Contributions to Management Science

Herbert Jodlbauer
Jan Olhager
Richard J. Schonberger *Editors*

Modelling Value

Selected Papers of the 1st International Conference on Value Chain Management

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Contributions to Management Science

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Selected Papers of the 1st International Conference on Value Chain Management, May 4th–5th, 2011, University of Applied Sciences in Upper Austria, School of Management, Steyr, Austria

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ISSN 1431-1941
ISBN 978-3-7908-2746-0 e-ISBN 978-3-7908-2747-7
DOI 10.1007/978-3-7908-2747-7
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2011940330

Printed on acid-free paper

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Editorial Preface

In the preparation phase for the first International Conference in Value Chain Management we conducted a Delphi Study with about 20 leading experts from all over the world. After four iterations the experts agreed on what Value Chain Management should be

Value Chain Management seeks to understand, to design and to control the entire network of relevant business partners in order to provide superior customer value and to ensure sustainable economic development of those partners as well as other interest groups.

According to the Delphi Study the most important key challenges which the world economy is facing are

- Meeting short term economic needs but at the same time taking care to ensure that the environment is exploited in such a way that future generations have the same opportunities and chances as we have.
- Coping with the following contrasting issues: the massive gulf between rich and poor; stable versus tense political conditions; well educated and illiterate populations; countries with high debt levels and money lending countries.
- Coping with the unbalanced availability of resources and demographic and socio-economic developments and environmental changes.

The Value Chain Management initiative contributed to meeting these challenges by addressing essential open questions in Value Chain Management, in particular:

- How to manage the shift from stakeholder self-interest to customer perceived value and sustainable economic development of all relevant partners; how to measure value chain performance and how to share the reward among the partners.
- How to coordinate, control and monitor networks, actors and processes including aspects such as volatility, risk, complexity, intense competition and the pace of market change.
- How the decision making process works in a network which bears in mind the interplay of individual behavioral aspects.

The Value Chain Management initiative has several initiators and supporters. I would like to say “thank you” to my colleagues in the editorial and scientific boards for ensuring a high quality conference and publication, to all reviewers for their sound feedback to the authors, to all authors and speakers for their fruitful contributions, to the session chairs and discussion moderators for carrying out the conference and to the organization committee for their perfect preparation of the conference and publication.

Herbert Jodlbauer
Editor in Chief

The management of value chains is becoming increasingly important, both for the individual firm and for the entire value chain. The transfer of finished products to the ultimate customer must meet the specific requirements of individual customers, in terms of price, quality, delivery, and other competitive issues. This sets the stage for what the entire chain must fulfill. Some suggest that competition in the future will be between value chains. But the firm perspective still dominates – e.g. profit and loss statements are established for individual firms, and not for value chains. However, for the firm it becomes increasingly important to belong to “good” value chains. This includes all aspects of sustainability, i.e. economic and environmental sustainability as well as social responsibility. If a firm is high-performing but belongs to poor value chains its existence will be still put to the test. A broad set of competences and capabilities will be required in the future for continuous competitive and successful operations. The Value Chain Management Conference has been established in support of such achievements. The 1st VCM Conference addressed many aspects of creating and managing efficient value chains – from strategy to execution using both theoretical and practical viewpoints. Different research methodologies were applied. The VCM Conference provided participants with ideas that likely will lead to even better research and new managerial insights.

Jan Olhager
Member of the Editorial Board

My first impression, when I learned of this inaugural Value Chain Management (VCM) Conference, was that it fills a void. The name suggested to me that the intended target and scope of the conference would be management of the value chain as an actual chain, rather than only separable pieces of it (for example, just distribution logistics or just production).

We academics tend, I think, toward reductionism, leading sometimes to suboptimal answers. Professionals in business do that, too – with poor results – perhaps largely because of weak collaboration among functions of the enterprise. Executives in charge of optimising the whole often make their own poor decisions. That is the tendency when senior people are not up-to-date on practices and issues in business segments of their company. In either case, the central issue is restricted vision.

The VCM Conference provided an attractive forum for research on these matters. Some of us presented findings on innovative operational practices along the value chain. Others offered theirs in regard to higher level thinking on how best to blend some of those practices for the good of the enterprise. My hopes and expectations are that we continue to learn from each other, expanding our own vision, thereby leading to more profound, useful research in the future.

Richard J. Schonberger
Member of the Editorial Board

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University of Applied Sciences in Upper Austria
School of Management, Steyr/Austria

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Special Thanks

The editorial team would like to express their special thanks to Michaela Lechner for managing the review process and Sophie Wiesinger for managing the publication process. The conference proceedings would not have been possible without their efforts.

Furthermore, the conference team would like to thank the following organizations for their sponsorship and support:

State of Upper Austria

Wissenschaftshilfe der WKO Oberösterreich/Upper Austrian Chamber of Commerce

Wiener Städtische/vienna insurance group

Sparkasse Oberösterreich

CATT Innovation Management GMBH

Part I

Keynotes

Invited Speakers:

David Walters
Jan Olhager
Martin Gooch
Richard J. Schonberger

Competition, Collaboration, and Creating Value in the Value Chain

David Walters

Abstract The network structure has expanded the nature of organisational economics from a limited perspective, based upon economies of scale (within which the firm became volume oriented striving to achieve its minimum cost/volume position on its long-run average cost curve (Chandler 1962), to a 'collective' perspective based upon a notion of dispersed operations (i.e., the complete range of value creation, production, delivery and service provision). It is no longer sufficient to be the *lowest cost provider* in a market but rather it is now essential to be the most effective and efficient *solution provider*: end-user markets are product-service dominated. These may be PRODUCT-service markets, however in the New Economy many industrial markets are product-SERVICE markets: the customers are aware of product application performance but are often more influenced by *service-maintenance availability* rather low prices, hence the approach by major manufacturers of such products as aero-engines which are priced by the hour of serviceable use. To be effective it is essential that suppliers and customers understand each others' expectations (value drivers) and costs (value driver response costs). The complexities of markets encourage a network approach, one in which "solutions" to customers' "problems" may take on a PRODUCT-service format or (increasingly) a product-SERVICE offer and the solutions will cross a number of international borders as well as a number of intra and inter-organisational boundaries during the process.

Keywords Business models • Collaboration • Globalisation • Productivity • Profitability • Regionalisation • Value drivers • Value added

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Keynotes Invited Speakers: David Walters, Jan Olhager, Martin Gooch, Richard J. Schonberger

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_1, © Springer-Verlag Berlin Heidelberg 2012

1 Introduction

> Value Chain Management seeks to understand, to design and to control the entire network of relevant business partners in order to provide superior customer value and to ensure sustainable economic development of those partners as well as other interest groups. *Value Chain Management Conference 04/05 May 2011*

Normann (2001) discussed "a new strategic logic"; suggesting: ". . .managers need to be good at mobilizing, managing, and using resources rather than at formally acquiring and necessarily owning resources. The ability to reconfigure, to use resources inside and particularly outside the boundaries of the traditional corporation more effectively becomes a mandatory skill for managements". As suggested by Normann the contemporary approach to managing resources is to leverage partnership resources rather than invest. This results in a reduced "asset footprint". With less investment, but participating in the same level of activity it should at least in theory be possible to produce a superior return on that investment at a reduced level of risk – in other words greater Value.

Successful Value Chain partners work together with other partners each of who offer complimentary expertise – assets, processes capabilities and capacities. Millennium (a US based pharmaceutical organisation) is an example. The CEO, Mark Levin described how Millennium identified that value generation in the industry was 'migrating' and how the Company has pursued the opportunities offered in a rapidly changing business environment by integrating the expertise of Millennium with those of other organisations. Millennium's approach is one requiring constant appraisal of market opportunities and a clear knowledge of the current 'worth' of the firm's abilities. See Champion (2001). The essence of the Value Chain network then is that it is a coordinated network of assets, capabilities and processes that have been identified as the most relevant to a specific market opportunity.

With the benefit of hindsight has the Value Chain concept been a useful tool in mapping, understanding and even predicting these changes? This paper argues that the answer is yes, and that the Value Chain has provided context for moving away from ownership of assets as the dominant paradigm to reducing asset footprints and participating in networks of businesses working together. Furthermore the Value Chain remains a valuable tool in plotting the future; in this context it can be used to monitor changes in market direction and changes in value expectations and value delivery models.

IBM is a leading example of an organisation that transformed its business model from a manufacturing dominated company into a service oriented company. It takes a leadership role in the global supply chain by offering integrated product and services to its customers. The change of the operation mode from product to service helps IBM acquire competitive advantages in the market place (Harreld et al. 2007). In order to successful in this transformation, firms must build dynamic capabilities to integrate, build, and reconfigure internal and external resources to meet the requirements of a rapidly changing environment (Teece et al. 1997). However this cannot be achieved unless the organisation is aware of the changes occurring in customer expectations. This is an example of *value migration* (Slywotzky 1997); "the increasing obsolescence of traditional business designs, a pattern of accelerating value migration away from increasingly outmoded business designs toward others that are better designed to maximise utility *(value)* for customers and profit for the companies." Hempel (2011) reports on the success that first Lou Gerstner achieved in steering IBM into the *high margins business of systems integration*, and the subsequent success of Sam Palmisano in developing IBM into an organisation that is strong in R&D and operates largely in Asia (India as a research hub) and there are seven "collaboratories" located in China and other Asian countries with customers; one example being a centre in Beijing to develop 'high-tech' railway systems. In 2010 sales were nearly $100 billion; of this R&D spending was 6 percentage.

A *PRODUCT-service* is a predominantly tangible product that provides a "hardware" solution to a customer problem and is clearly applicable to both B2B and B2C market sectors. As competition intensifies the service content of the package can become a critical factor in vendor/customer relationships and at a particular time (or situation) in the relationship the PRODUCT-service becomes a product-SERVICE. Johnson (2010) describes the problems of Hilti (hand held power tools) who in the late 1990s realised their market was being overtaken by competitive products. Hilti was a premium product in a market segment that did not identify 'value' as being a premium brand. Users began to view hand power tools as disposable and treated them as such; neglect decreased productivity and increased repair costs; and tool management became difficult and costly. Hilti revisited its *value proposition* and saw an opportunity to reposition their power hand tools as a *product-SERVICE* that could compete in markets on convenience. Hilti began to lease its products and the Company rather than customer maintained the product, offering a high level of availability of reliable equipment at all times. Johnson does not identify a partner role in this change of direction; however it is likely that some involvement was required to finance the increased inventory and possibly a service organisation maintained the equipment. The program was very successful moving from a pilot program to being rolled out to most of Hilti's international markets in 3 years. Vigilant market observation of value migration (which is precisely what the Hilti example is about) the shift in the value proposition from PRODUCT-service to product-SERVICE can be planned and, if required, provides time for partner organisations to be located and into the new value offer.

2 The Developing Network Based Business Model: "Brics", "Clicks" and Beyond

Gordon Brown 2010), former prime minister of the UK, considered the future reality of the-post GFC business environment. The collapse of trade in 2009, the large increases in unemployment and the consequent reduction in living standards requires an international financial and economic strategy.

Brown discussed the role of Asia in the coming years: China will soon overtake the USA as a manufacturer and this will be reflected in the investment in capabilities and capacity. He suggests that despite the current (2010/11) problems of low growth and high levels of unemployment both the US and Europe can play a major role in the next decade and beyond. Brown argues that the rapid, and massive, expansion in Asian manufacturing Asian producers will become new middle class consumers. Currently Chinese consumer spending is 3 percentage of world economic activity compared with the European and USA's 36 percentage. He suggests that by 2020 or so, Asia and the Emerging Markets will bring double America's consumer power to the world economy; he points to GE, Intel, Proctor and Gamble as having announced that the majority of their growth will occur or come from Asia

Gordon Brown sees Asian consumer growth as "the exit strategy from our economic crisis". Business is now relatively well equipped to respond to this challenge; the functional "silos" have given way to a customer focused process approach with processes now developed well beyond the intra-organisational approach and are inter-organisational in their operations with many crossing international borders (see Fung et al. 2008).

The strong growth is likely to continue in China and India (close to 10 percentage) compared with very poor growth in Europe, Japan and the US of a little over 2 percentage!!! Winestock (2010) cites Stephen Walters (JP Morgan, Australia) who suggests the structural change in the global economy, particularly the rise of China and India, has further to run!! There are important implications here; Asia has become the manufacturing engine of much of the world and businesses in the rest of the world must now accommodate the changes this demands of them.

What are the implications for the 'emerging business model'? Iansiti and Levien (2004) made a significant comment some 6 years ago: "Strategy is becoming, to an increasing extent, the art of managing assets that one does not own". Arguing that business networks are ubiquitous in our economy they suggest the pervasive networked nature of our business environment has triggered a significant evolution in the design of business operations and in the role of managers. Business networks did not start with the Internet; their pervasiveness is the result of as evolution in social, economic, political and technological systems that have stretched over the last few centuries." The authors comment on the structure of the Italian apparel industry (Prato, Northern Italy) that has been a loosely structured network of a number of specialist provider organisations (often comprising one person) that responded successfully to intensive competition in the 1950s/60s and that owed its existence to the structure that originated in Renaissance Italy in which an *impannatore* integrated and coordinated their activities. See Piore and Sabel (1984) for a detailed account of this early network based business model.

2.1 Moving on from "Mass Customisation" to a "Market of One"

Zuboff (2005) discusses the progressive role of the business model evolution in "creating value in the age of distributed capitalism" by introducing the notion of *mutations*. Zuboff argues that the leading edge of consumption is now moving from products and services – to tools and relationships enabled by interactive technologies. *Amazon.com*, *Apple*, *eBay*, *and YouTube* being familiar examples, and identifies lesser-known companies like *CellBazaar* in Bangladesh (in emerging-market mobile commerce in rural locations), *TutorVista* (in tutoring), and *Livemocha* (in language education). While *innovations improve the framework* in which enterprises produce and deliver goods and services; *mutations create new fram*eworks; they are not simply new technologies (much more process innovations based on applying technological innovations), though they do leverage technologies to do new things. Historically, mutations have superseded innovations when fundamental shifts in what people want require a new approach to enterprise: new purposes, new methods, and new outcomes. In the way that mass production moved the locus of industry from small workshops to huge factories, today's mutations have the potential to shift us away from business models based on economies of scale, asset intensification, concentration, and central control. Zuboff argues that for many goods and services, new business frameworks are emerging: federations (value chain networks) of enterprises – from a variety of sectors – that share collaborative values and goals are increasingly capable of distributing valued assets directly to individuals, enabling them to determine exactly what they will consume, as well as when and how. This shift not only changes the basis of competition for companies but also blurs – and even removes – the boundaries between entire industries, along with those that have existed between producers and consumers.

Zuboff's argument is that the technology of mass customisation and of product platforms provides a means of 'offering most of the market, most of what it wants'; in other words the concept of "dispersed manufacturing" as practiced by Li and Fung (Fung et al. 2007) supports mass customisation. Zuboff's mutations concept creates business model structures that permit and indeed require customer participation (co-creativity) in the production of more closely individualised product-services. This suggests that network business model design is becoming *process innovation* led. Distributed capitalism takes the technologies associated with the Internet, mobile computing, wireless broadband and related developments in digitization and software applications and creates a convergence of technological capabilities and the values associated with the product-services required for individual self-determination.

2.2 *Enter the "Printed" World of Additive Manufacturing: "Customisation Becomes a Reality"*

The Economist (2011) explored the world of the *fabricator*, the application of 3D printing technology to manufacturing. Designers and Engineers have been using 3D printers for more than 10 years; initially to produce prototypes rapidly and at low cost. Currently they are now capable of using a wider range of materials (plastics and metals) and their accuracy is been developed such that it is estimated that more than 20 percentage of the output from 3D printers is now final products and this estimated to have increase to 50 percentage by 2020.

It is likely that Additive Manufacturing will have a major impact in the value chain network by lowering both fixed and variable costs. The equipment (the fabricator) now costs less than a laser printer did in 1985, it is compact and does not require anywhere near the production facilities currently in use producing similar products. Savings in variable costs are realised by the savings in raw materials, where it is estimated 3D printing uses some 10 percentage of input materials.

The Economist argues that: "The industrial revolution of the eighteenth century made possible the mass production of goods, thereby creating economies of scale which changed the economy – and – society – in ways that nobody could have imagined at the time. Now a new manufacturing technology has emerged which does the opposite". In the mid-1990s *mass-customisation* was offering considerable competitive advantages; now *customisation* offers the potential of not just exclusiveness but of uniqueness. The Economist suggests potential for focusing RD&D in central locations that is linked by ICT to the market place, thereby expanding the notions of Rayport and Sviokla and those of Zuboff.

2.3 *The Factory of the Future*

Barkai and Manenti (2011) argue that current market trends require the future production environment to be highly adaptable and reconfigurable to respond to rapid changes in market demand, technology innovation and changing regulations. Flexible manufacturing technologies employed by most automakers are a critical ability in this process and the foundation for profitable growth, but these alone will not suffice in a long term strategy to fend off the competition. The authors suggest a practical "design anywhere, make anywhere, sell anywhere" strategy is needed, and propose, arguing that:

> Factories of the future will be a global network of production facilities managed as single virtual factory. This type of manufacturing network consolidates multiple resources and capabilities to form an end-to-end fulfilment network that we call fulfilment execution system (FES).

FES is an approach to a coordinated management of demand, capacity and resources, and outbound order fulfilment across the entire network of manufacturing plants and along the supply chain. Data gathered will be connected to corporate-level intelligent decision support tools, creating visibility and intelligence on operational data. It enables manufacturers identify problems, isolate root causes, understand the state of execution processes, and adopt corrective actions quickly across multiple plants. The authors' proposal takes us beyond the *marketspace/marketplace* work by Rayport and Sviokla (1995) in which they suggested the traditional marketplace interaction between physical seller and physical buyer are being eliminated. In the marketspace the content of the transaction becomes information, the marketplace becomes a screen interaction using electric media. Costs are lower, convenience increased and the process more transparent. Table 1 is this author's interpretation of the FES system in a "value" context.

Table 1 Value: content, context, and value production and delivery format

MARKET*PLACE* PHYSICAL *(TANGIBLE)*	MARKET*SPACE* VIRTUAL *(DIGITAL)*
VALUE CONTENT	VALUE CONTENT
• PRODUCT-service based	• Product-SERVICE based
• Tangible/hardware	• Variety of benefits/flexible
• Fixed benefits/inflexible	• Intangible/"software"
• Requires service	• No service costs
• Requires replacement	• No replacement costs
VALUE CONTEXT	VALUE CONTEXT
• Face2face communications (negotiations and transactions)	• Electronic communications (e-negotiations and e-transactions) 24/7 access
• Specified business hours access	• Predominantly global markets
• Predominantly local markets	• "Informediaries" may be required
• Intermediaries may be required	• Intermediaries unnecessary
• Physical evaluation (touch and feel)	• Purchased against specification
Value production and delivery format	Value production and delivery format
• Physical production and distribution network structures	• Virtual/digital production and distribution network structures
• Inventory required	• No system inventory
• Storage facilities required	• Electronic distribution
• Transportation	• "Immediate" delivery
• Order cycle time required	• "Virtual" service facilities

2.4 A Place for Everyone and Everyone in Their Place

The growth of globalisation and now regionalisation have extended the boundaries of the organisation to include nationally and internationally based partners. In addition to the changing attitude to strategy, structure and location, the move towards organisations as being partners within networks, operating as providers of specialist product-services within specialist markets is significant. There are examples of SME organisations competing in this role.

In Germany the term *Mittelstand* is sometimes applied to quite small, parochial firms, the most interesting ones are rather bigger and more outward-looking. Most (some 90 percentage of them) operate in the business-to-business market and 70 percentage are based in the countryside (Economist 2010). They focus on market niches, typically in areas such as mechanical engineering. *Dorma* makes doors and all things door-related. *Tente* specialises in castors for hospital beds. *Rational* makes ovens for professional kitchens. This strategy helps them avoid head-to-head competition with global giants. It has helped them excel in these market niches. *Mittelstand* companies dominate the global market in an astonishing range of areas: printing presses (Koenig & Bauer), licence plates (*Utsch*), snuff (*Pöschl*), shaving brushes (*Mühle*), flycatchers (*Aeroxon*), industrial chains (*RUD*) and high-pressure cleaners (*Kärcher*). Globalisation has been a godsend to these companies: they have spent the past 30 years of liberalisation working quietly to turn their domination of German market niches into domination of global ones.

Japan also has a number of very successful medium sized organisations – *chuken kigyo – strong medium sized firms* that have a number of these organisations: *Shamano*, 60/70 percentage of world's bicycle gears and brakes: *YKK*, 50 percentage of world's zip fasteners: *Nidec*,75 percentage of world's motors for hard disk drives in computers: *Mabuchi*, 90 percentage of world's micro-motors used to power the adjustment of rear view mirrors in automobiles: *TEL*, 80 percentage of the etchers used in LCD panels: *Covalent*, 60 percentage of containers that hold silicon wafers as they are converted into computer chips: *Murata*, 40 percentage of world's capacitor market (50 percentage margin): *Japan Steel Works*, 100 percentage of the world market for solid steel containers that contain radioactive materials.

It is certain that the "New Economy", whatever format that it eventually takes, will be influenced by this business model format and it is noticeable that in those countries where manufacturing rapidly migrated to Asia as it became industrialised (to the extent that it now dominates a number of sectors) there are signs (such as those suggested by the *Mittelstand* model) that being part of a value chain network can reduce the exposure to *high volume/low value* competition and that profitable opportunities do exist. The Economist article identified three 'general lessons': the Silicon valley type cluster *is not* essential to succeed; a focus on traditional strengths in established industries appears to be sufficient. A second point is that niche markets can integrate into large global activities. And third; sustained focus on capabilities with innovative products and processes has rewards. It can be argued that by identifying a specific customer 'solution' corporate size and distance are becoming irrelevant. Indeed if this is a core 'need', one shared by most members of an industry it is very likely that economies of scale will return in importance.

This may be more difficult than it would appear. Majocchi et al. (2010) offer an interesting view of current issues and future prospects. In a presentation in New York (10 October 2010) the "Challenges of global manufacturing: improving North American and European competitiveness through cooperation", they identified a number of issues. There is reluctance among NA manufacturers to pursue global growth opportunities particularly in the emerging BRIC economies where dramatic growth is expected as “hundreds of millions” of consumers continue to expend. However this growth may well not be matched by manufacturing capacity. The authors comment on a survey by HSM Americas Inc., suggesting that while European manufacturers have learned how to serve the diverse needs of customers spread across the globe and have developed the know-how to cooperate with other companies in vertically-integrated value chains, North American manufacturing companies, especially small and medium sized enterprises, have not responded similarly and need to refine production capabilities for mass customisation in order to explore the potential overseas. This includes taking advantage of green technologies – before regulations require it – which can help establish a competitive advantage in the global marketplace. These comments suggest that very few would embrace the future predicted by Zuboff.

Some major differences between European and North American organisations were found. European manufacturers expressed a greater interest in increasing their production flexibility to attract business than their North American counterparts, who were more focused on reducing labour costs in the last 2 years, to offset economic challenges. In addition, fewer North American manufacturers were investing in innovation or R&D than the Europeans. And green manufacturing initiatives, which can help drive down material costs and spur needed innovation, were embraced in greater numbers in Europe than in North America. The authors suggest some guidelines to initiate a move towards both effectiveness and efficiency: strengthen mass customization capabilities, leverage the power of partnerships, and, take a chance and learn about export opportunities. They concluded by commenting that it is a difficult transition, requiring cultural and structural change, adding that waiting is not an option, given the fact that competitors in China, India, Brazil and other emerging economies are moving fast to fill the void.

However, these comments do not necessarily apply to a significant number of “aware” North American manufacturers. Papers at the IMS (Intelligent Manufacturing Systems) Vision Forum 2006 made similar suggestions concerning future activities. Jason Myers (2006), Canadian Manufacturers & Exporters, Canada, identified four ‘agents of change’ for *Next Generation Manufacturing*: customised solutions, a lean approach, ‘the competitive batch of one”, and, “managing time”.

Myers suggested that manufacturing responses are already operating in the context of value chains that compete against each other; suggesting further that the extended businesses of the future will be virtual enterprises in which business units continuously reconfigure their operations, collaborative partnerships, and supply chain relationships, forming and reforming value chain networks on a project by project basis, relying upon value chain networked information systems and virtual engineering to ensure *concurrent* design, production, marketing, service and sales support. They will operate as if their firms are members of a single and flexible enterprise. There can be little doubt concerning the impact of these developments on all operations processes, particularly manufacturing and sales, and logistics and supply chain management processes.

3 Globalisation, Regionalisation and Regional Collaboration

The "eighties and the nineties" was a period of globalisation; the "noughties" was one of moving towards regionalisation; the "teens" will be a period of collaborative regionalisation. There is an interesting difference of philosophy. During the "noughties" large international organisations realised that their investment in the *emerging markets* created consumer wealth and an increase in disposable incomes, so much so that the 'providers of low-cost labour' became consumers of their labours. Initially low labour costs and economies of scale (due to product range management) offered strong incentives but the expansion of the domestic markets increased the attractiveness. As we have seen in recent months automobile sales in China are breaking growth records.

3.1 Globalisation

It is interesting to compare current but divergent global business models in the same industry. *Ford Motor Company* are developing global platforms that have streamlined the way the company builds cars for markets worldwide and is one of the key cost restructuring initiatives that helped return the Dearborn-based automaker to profitability. At Ernst and Young's Strategic Growth Forum on November 10, 2010, at which Executive Chairman Bill Ford discussed his company's turnaround and other key auto industry and manufacturing issues. The company's move away from building cars uniquely for individual countries along with successful collaboration with its union leaders has brought costs down significantly and the company's latest Ford Explorer model is being built in Chicago and will be exported to 93 different countries. The plan is to continue to export from the U.S. to around the world pursuing a "One Ford" global design and development strategy with only small adjustments for local tastes. More recently Alan Mulally, Ford CEO, has commented; "You have to match production to real demand and accelerate development of new products that people will want to buy." For Ford, that meant restructuring and borrowing $US23.5 billion, and for GM and Chrysler it meant bankruptcy filings and federal government bailouts. (Hirsch 2011). The new Ford Focus will be built on one platform and will have the same engine, transmission, chassis and main body in all markets where it is sold. Figure 1 describes this global business model being used by Ford and other large international organisations.

Whirlpool acquired the home laundry assets of *Philips NV* recently to pursue a similar strategy. Whirlpool have also formed a joint venture last year with China's *Hisense Kelon* Electric Holdings Corp, in which each firm has a 50 percentage stake, for the development and production of washing machines and refrigerators. The relocation to the joint venture factory, which also makes refrigerators, will create 900 jobs by the end of 2009. The company said the move would cut costs and lead to economies of scale.

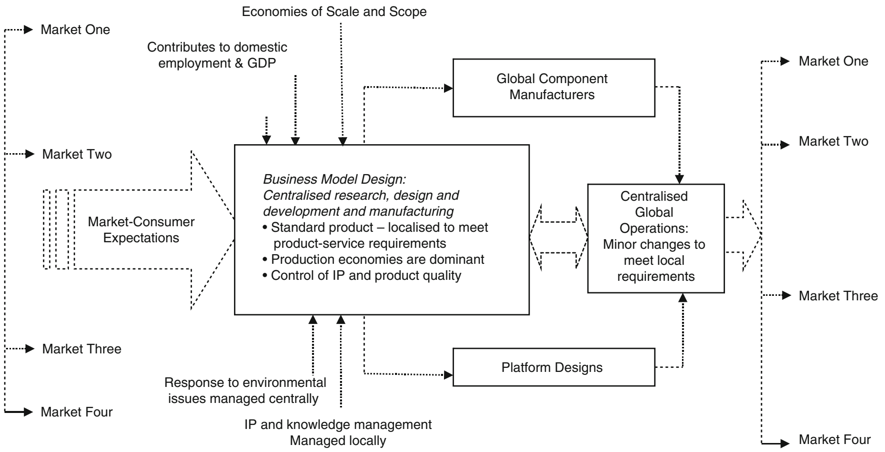


Fig. 1 Global operations business model automobiles and consumer durables

Globalization has a profound on-going effect on the automotive industry. Growing operational complexity, diverse markets and high consumer expectations are forcing automakers to move away from capitalizing purely on economy of scale and embrace a mind-set of economy of scope, focusing on global flexible manufacturing capabilities.

3.2 Regionalisation

Regionalisation is increasing. It is becoming clear to a number of organisations that re-engineering products simply to reduce costs is not as effective as redesigning them to meet local requirements and for them to be manufactured locally to create goodwill, to take advantage of reductions in costs and, adding prosperity and spending power by providing employment. General Electric (Healthcare) is practising *reverse innovation*, best described as:

> Offering a 'fifty percent performance solution' at fifteen percent of the cost of the one hundred percent solution. (Immelt and Govindarajan 2009).

GE introduced *reverse innovation* because it found that the traditional approach of developing sophisticated products in domestic markets and simplifying them for emerging markets was not effective primarily because of declining growth rates in developed markets and innovative competitors in the emerging markets. GE introduced a business model based upon five principles: Local Growth Teams were established in India and China. The LGT management model was created featuring; delegated product-service strategy shifting decision making to sourcing/ consumption markets, LGT structures can respond to local circumstances in planning processes: opportunities and constraints and reflect local market, finance and operations realities, and whose objectives and strategies become 'customised' to meet local (realistic) possibilities and constraints.

It is interesting to note that these "basic" healthcare monitoring products do have markets in the traditional markets as the impact of the financial problems of 2009 has constrained business and consumer expenditure.

Panasonic's EM-WIN program operates in "BRIC", and other emerging markets (Brazil, Russia, India, China, Vietnam, Mexico, Indonesia, Turkey and the Balkans). Panasonic estimates that sales to EM – Win markets will exceed sales to North America and Europe. EM-WIN has been a major activity for Panasonic over 2 years (2007/9). Panasonic undertook 'Lifestyle research' in order to redesign products to meet local requirements – reduced features and reduced manufacturing costs. By reducing features and localising design and manufacturing, costs can be reduced to reach acceptable prices: pricing targets are television $US50, air conditioners $US100, washing machines $US200; removing unnecessary features simplifies the manufacturing processes and requires fewer parts and permits the introduction of standard parts and platforms (Wakabayashi (2009) WSJ.com, The Australian, 10 July).

Following an initiative from the Japanese Government Toyota has indicated a move towards regional activities; it will invest nearly $700 million in its first fully-fledged research and development base in China in a bid to expand its share of the world's largest auto market. Toyota Motor Engineering & Manufacturing (China) Co. Ltd. will build the plant at an economic development zone in Changzhou, near Shanghai, with plans to begin operations in the spring of 2011. The new company will survey the Chinese auto market, study quality control at its local assembly plants and develop low-emission vehicles and engines for the local market. The company plans to raise the number of employees from an initial 200 to 1,000. "TMEC . . . aims to tailor vehicles to the demands of Chinese consumers." Agence-France (2010). Figure 2 identifies a typical regionalised corporate business model.

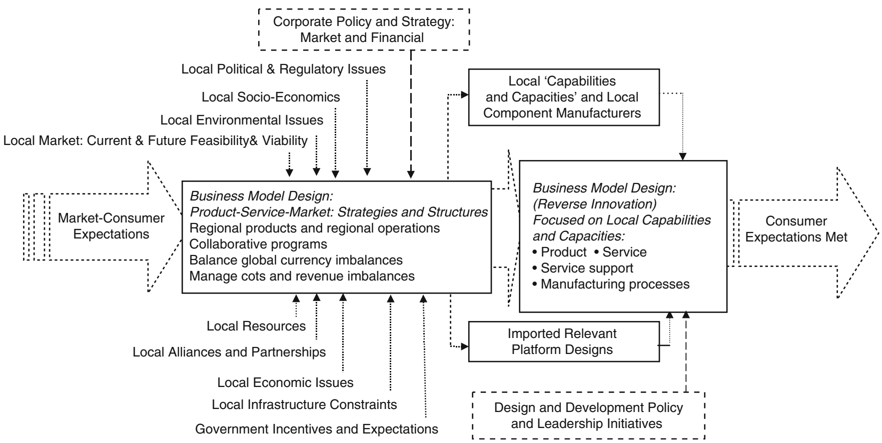


Fig. 2 Regional operations business model automobiles and consumer durables

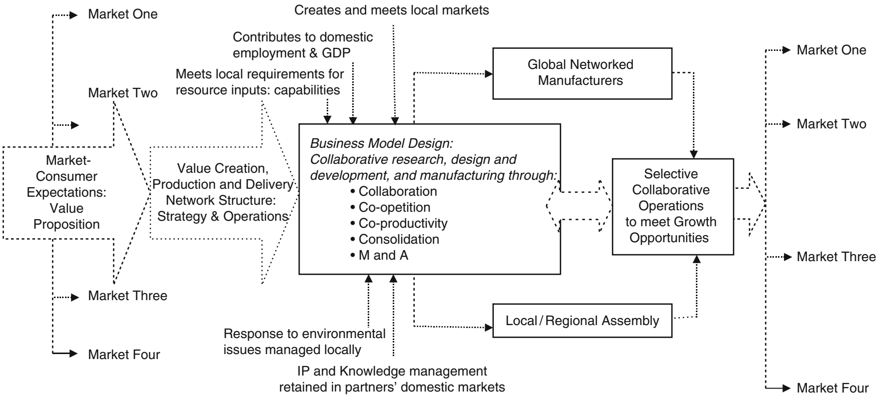


Fig. 3 Collaborative networks consumer and consumer

Many companies are taking a more creative approach to mobilizing resources. Grey (2006) discusses collaboration from a resource management perspective; arguing that rigid resource based systems, typically those such as highly automated factories operating with rigid and standardised processes that apply resources to specific places at predetermined times, are becoming obsolete. See Fig. 3. Grey's argument is that resource mobilisation (the increasing externalisation of tasks and a corresponding increase in cooperative arrangements or networking.) is; "a necessary response to fragmenting less predictable demand. The Bishops Technology Group (Grey's company) collaborates with partners across the world to develop new innovative products. Grey suggests that an important facet of this activity is the relative ease with which information that flows between ODMs, suppliers, logistics providers, distributors, wholesalers and retailers can be captured to provide valuable feedback input concerning the efficacy of product design, and distributor and customer response.

This suggests a major difference between *rigid resource* systems and *mobilised resource systems*. Rigid resource systems are the traditional "push" manufacturing model in which production is based on sales forecasts and products when finished are moved into a finished goods inventory awaiting sale. Mobilised systems, the *pull approach*, use demand chain analysis to identify opportunities and then identify the resource base required to compete successfully, and, in doing so expand (or contract) the resources network. This extends to the end-user customers who become *co-creators* by participating in the design process. This approach does not infer that the final output of the mobilised resources model is a highly customised, unique product; it is suggesting that customer satisfaction can be more closely achieved by using product and process platforms as modular systems that can be combined in a number of ways to meet end-user demand. Examples of *product platforms* are seen in the automotive industry where platform components are shared on an intra- and inter-organisational base. Examples of *process platforms* are seen in Internet merchandisers such as Amazon, e-Bay and AliBaba.

VW and Suzuki are working together in India to design and manufacture small vehicle range to extend the concept into one of *Regional Collaborative Networks*. And Tesla Motors Inc. receiving approximately US$60 million from Toyota to research and develop an electrical powertrain system for a new version of Toyota's RAV4 SUV is an example *Product-Service Collaboration*; as is the project that ***Lego*** have launched (a "Classroom of the Future" project with MIT)to teach children about science and technology; launched "LegoFactory.com" a "Lego Digital Designer" that offers an opportunity to design and order a unique Lego model, and; a joint venture with the MIT Media Lab that introduces robotic Lego.

Australian companies that are responding to the need to work as a component of an international value chain network includes: *Peregrine Australia*; manufactures a radio frequency sapphire water chip combining antenna and amplifier for 'top-end' mobile phones; *GPC Electronics*, *Sydney*; Superior quality of systems and management (flexibility and complexity) has resulted in negotiated supplier lead times of two weeks and order response times for customers of 4 weeks; *Bosch Melbourne*; R&D led customised manufacturing that requires extensive *knowledge IP inputs* provides customers with market exclusivity/differentiation without extensive R&D expenditure; *Codan communications equipment supplier*, *Adelaide*; products based on standard modules reduces inventory holding and order lead times providing a 5/10 day order response time in comparison with competitors' 4 weeks or more; *GPC Electronics*, *Sydney*; *s*uperior quality of systems and management (flexibility and complexity) has resulted in negotiated supplier lead times of 2 weeks and order response times for customers of 4 weeks.

International examples of collaborative strategies are also abundant and include: *Endo Pharmaceuticals/UPS (Healthcare Division)*: After acquiring DuPont's drug division positioned itself in the VCN to distribute prescription and other drugs in the US from contract manufacturers in overseas locations. Endo has a partnership in which leases space and UPS's expertise at handling controlled substances; *Lego* launched a "Classroom of the Future" project with US university to teach children about science and technology; launched "LegoFactory.com" a "Lego Digital Designer" that offers an opportunity to design and order a unique Lego model, and; a joint venture with the MIT Media Lab that introduces robotic Lego; *Philips NV*: team up with academic and industry with comparable research interests and capabilities to work on industry standardisation and technology developments; *TomTom (GPS)*: identified its capabilities to be in 'innovating' in a particular area of technology and its understanding of consumer needs in the area. It established a manufacturing outsourcing capability – rather than a manufacturing expertise; *Hewlett-Packard*: Outsources 90 percentage of its manufacturing volume to some 40 suppliers. HP's core capability is now focused on 'managing contract manufacturing' and *UPS Inc. who* provide resources that enable both small (and some large) organisations to operate as *large organisations* in large global markets; linking eBay and PayPal with UPS processes to enable purchases to facilitate tracking during delivery; managing the repair service processes for Toshiba computers in the US; a complete redesign of the Ford vehicle distribution system in North America; to reducing inventory holding, and to reduce the inventory cycle from one month to 10 days, and improving the accuracy of orders/deliveries.

There is a suggestion here that in successful value chain networks we see "collaborative competition" as a preferred competitive model. The UK Government identified this trend in a report it commissioned into the Aerospace industry

> The business model of the future will be value chain competing against value chain, not just single company versus single company as we witness predominantly today. Supply chains will have evolved to include the end-user or consumer in value creation and through this will have become known as value chains. AeIGT (2003) an independent report on the Future of the UK Aerospace Industry: The Department of Trade and Industry, UK

The report concluded that the industry was not ready to make this adjustment at that time.

The new approaches have introduced a new vocabulary. Terms such as *Co-creativity* – the involvement of consumers in the design of products; a creative role that results in products that meet *specific needs* of customers. *Co-productivity* is a more operational role by suppliers, distributors and customers in which they undertake tasks that hitherto were the role of other channel/chain participants. *Co-opetition* describes the situation in which competitors work together to meet individual objectives using mutual facilities. Figure 4 provides examples of these concepts being used.

3.3 Collaborative Competition: Optimal Returns with Optimal Risk?

The financial events and difficulties of 2008/2009 have led to difficulties in obtaining funds for development by even the relatively low risk organisations; resulting in a review of strategy, acceptable levels of risk, and of the synergistic benefits of network based collaborative strategies. Strategy models such as Blue Oceans Strategy (Kim and Mauborgne 2005) argue that the in "New Economy" competition becomes irrelevant. Their *Blue Ocean Strategy* considers how to create uncontested market space and make competition irrelevant. Their argument is that *value innovation* is the basis of Blue Ocean Strategy. By contrast a *Red Ocean Strategy* is one in which an industry's structure is such that firms are forced to be competitive with each other. Blue Ocean practitioners do not perceive of market structures and boundaries; rather these exist in the minds of managers who are prepared to accept them as constraints that need to be worked around competitively. The authors argue that *value innovation* is a process of creating buyer value *and* reducing costs *simultaneously*, it is a whole systems-approach to the creation of a sustainable strategy. This author would suggest the marketplace/marketspace that is evolving is viewing the slow growth rates in business and the return to very low rates of employment compared with those prevailing prior to 2008/9 with caution;

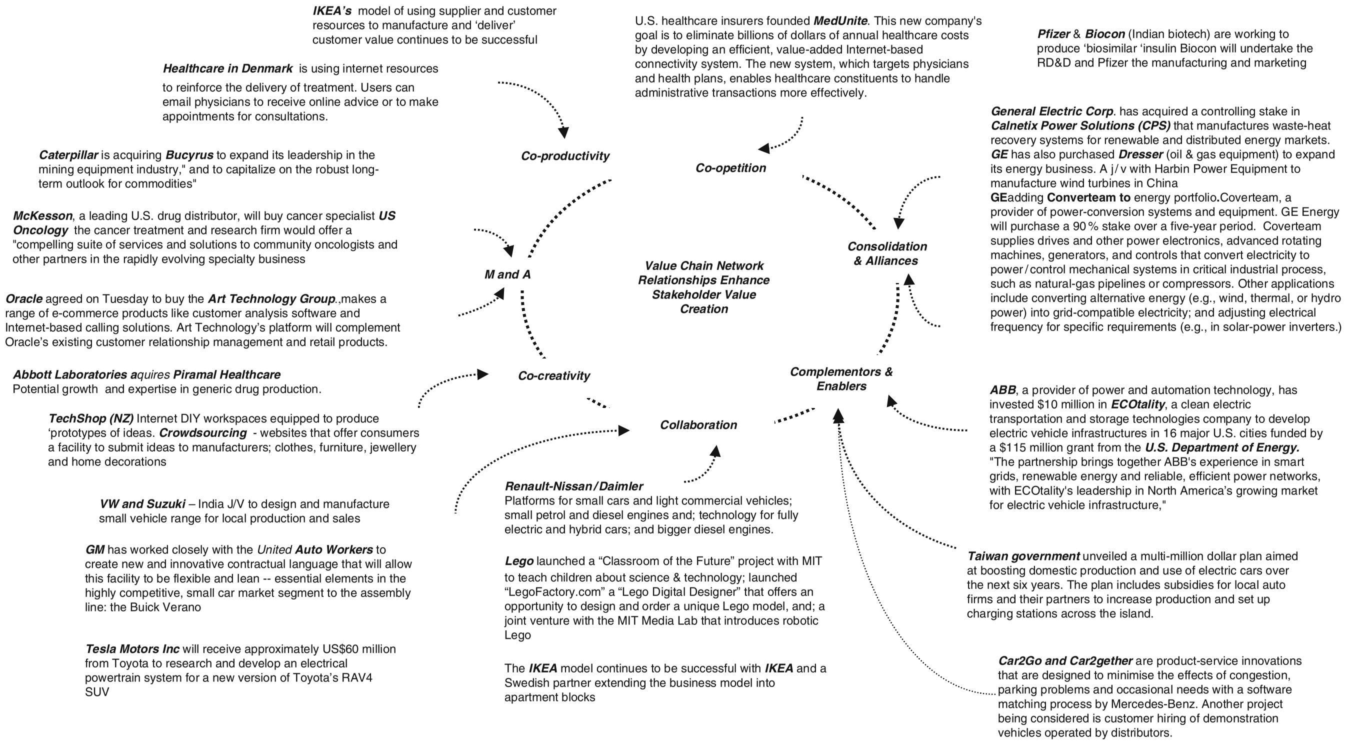


Fig. 4 Using VCN relationships to achieve stakeholder satisfaction

indeed they may not return to those experienced prior to the "GFC" as businesses have restructured operating methods around uncertainty. Perhaps rather than be considering a cruise on a *Blue Ocean* we should be considering a fishing trip with a group of likeminded 'colleagues' on a *Golden Pond. Golden Ponds* are market opportunities typically requiring some resources that are external to the firm but are *value innovations* as defined by Kim and Mauborgne. Two differences are noticeable; 'golden pond strategies' are network based, and, are highly likely to *offer less risk* as the essence of the network structure is to 'share' the network system risk – as well as the returns. It is arguable that Blue Ocean strategies create new and unique product-services in essence they deliver new and (for a while) interpretations of the benefits of core products. *Golden pond strategies* approach this by engaging with partner organisations to lower risk and investment requirements.

Figure four suggests a number of these are offering successful alternatives: *Abbott Laboratories* (strong in production, marketing and sales operations) acquired *Piramal Healthcare* (offering growth and expertise in generic drug production).; U.S. healthcare insurers founded *MedUnite* (an example of co-opetition). This new company's goal is to eliminate billions of dollars of annual healthcare costs by developing an efficient, value-added Internet-based connectivity system. The new system, which targets physicians and health plans, enables healthcare constituents to handle administrative transactions more effectively. And, *ABB*, a provider of power and automation technology, has invested $10 million in *ECOtality*, a clean electric transportation and storage technologies company to develop electric vehicle infrastructures in 16 major U.S. cities funded by a $115 million grant from the *U.S. Department of Energy*. "The partnership brings together ABB's experience in smart grids, renewable energy and reliable, efficient power networks, with ECOtality's leadership in North America's growing market for electric vehicle infrastructure." The notions of "markets of one", internet DIY workspaces (*TechShop* (*NZ*)) equipped to produce 'prototypes of ideas' and of 'crowdsourcing – websites' offering consumers a 'co-creativity' facility to submit ideas to manufacturers; clothes, furniture, jewellery and home decorations, and of "collaborative competition" suggests a need to expend more effort in understanding the value creation/production processes and specifically the changing role of the customer in the process.

4 Understanding Value Drivers Creates Opportunities for Collaborative Competition in the Value Chain Network

Slywotzky and Morrison (1997) introduced the term "customer-centric thinking". Using a "customer-centric" approach to the value chain network suggests 'things that are so important to customers' are the customers' *value drivers*, those adding *significant* value to customers and to customers' customers. Value drivers assume two-fold significance. One is clearly that of the role of the process of identifying and adding *relevant value* for customers and its ability to differentiate the value offer such that it creates competitive advantage for both the customer and the supplier organisation. The second is that like their customers, suppliers also have value drivers, and the process of creating value creates costs for supplier organisations, thereby raising questions on the impact on the value *and* cost drivers of the supply/vendor organisation. Management's task within network structures is to create an optimal stakeholder solution whereby both vendors' and purchasers' value driver expectations are met and benefits are shared.

Phelps (2004) considers value drivers (and builders) from the perspective of the organisation. Identifying value drivers begins by asking "What drives value in your business? Who are the competitors? What are the characteristics of the market?" The value drivers in any business depend on the specific setting, competition and the market structure Their time perspective is clearly short-term given they are factors that "drive present value" and as levers of present value. Focus on adjustments to the value drivers results in short-term improvements in performance. Value drivers include adjustments and operational implementation characteristics such as; product mix, manufacturing and distribution capacity, employee motivation, supply chain configuration, generating strong positive cash flow, excellence in customer service, etc. Phelps argues there are no generic value drivers, they can be as diverse as brand image for one organisation and employee recruitment policies for another: what is common to all organisations is that value drivers create short-term performance improvements.

4.1 Value, Added Value, and Value Drivers

In a business context, value implies stakeholder satisfaction, which is a broader consideration than simply customer satisfaction. Stakeholder satisfaction ensures that not only are customers' expectations met, but also those of employees, suppliers, shareholders, and the investment market influencers, the community and government. Clearly these differ among the stakeholder spectrum. As organisations become components of value chain networks (and as such operate to create value for the network as well as to create value to meet their own stakeholder needs) there is an immediate responsibility to consider inter-organisational network system added value as a means of increasing productivity within the network as well as for the end-user customer.

Understanding the importance of "value" to customers and other stakeholders helps strengthen relationships between, and among, customers, suppliers, shareholders and investors and an organisation as these "value based" relationships are the link an organisation needs if it is to develop a strong competitive position. To do so it clearly needs to identify the *value drivers* (and value builders) that are important to the end-user customer to structure a value delivery system that reflects these *and* the objectives of the other value chain participants, using Slywotzky and Morrison's notion that the important value drivers are those adding *significant* value to customers (these are likely to demonstrate a Pareto (80/20) profile). Within the of a value chain network, value drivers assume significance. One is clearly that of the role of the process of adding *relevant value* for customers and its ability to differentiate the value offer such that it creates competitive advantage for both the customer and the supplier organisation. The second is that like their customers, suppliers also have value drivers, and creating value creates costs for supplier organisations, thereby raising questions on the impact on the value *and* cost drivers of the supply/vendor organisation. Clearly these two issues are linked as a supplier's value drivers include supplier financial performance and it follows that unless the marginal revenue generated by enhancing a value driver exceeds its marginal cost there would be little point in pursuing the proposal.

In the increasingly *virtual*, *or network*, *world* in which businesses are becoming responsible for a limited role in the value creation process) five questions emerge:

- What is the combination of value drivers required by the target customer group? What is the customer groups' order of priority?
- What are the implications for differentiation decisions? Are there opportunities for long-term competitive advantage?
- What are the implications for supplier/vendor's cost structures and value drivers?
- Are there opportunities for trade-offs to occur between the value chain network partners that may result in *increased* customer value (and stakeholder value) or *decreases* in the value system costs or the costs of the target customer group?
- What are the implications for corporate productivity of a focus on value drivers (and their associated) cost drivers? How are they linked?

Phelps *op cit* argues that it is insufficient simply to measure outputs to know if we are creating value; the (value) drivers of present and future value must also be measured. Measuring output indicates success (or perhaps lack of it) whereas understanding (and measuring) what it is that drives value provides management with an indication of the success of resource allocation. Phelps also argues that it is important to distinguish between factors that drive current value (suggesting cost reduction as an example) and those responsible for creating future value (such as brand development and research, design and development). He makes the point that overlap may occur; value drivers may well contribute to building both current and future value.

Identifying value builders "gives the ability to take advantage of risks and opportunities as they arise". The author suggests organisations take a strategic perspective by identifying potential market developments and then addressing the scenarios with 'positioning decisions' (i.e., develop ownership or access to resources) that will enable the organisation to move rapidly into an opportunity. Phelps suggestions are in fact, equally applicable to the value producer and the value consumer in a B2B context.

4.2 Value Drivers and Value-Led Productivity

The *value drivers* in any business depend on the specific setting, competition and market structure(s). Focus on adjustments to the *value drivers results in short-term improvements in performance*. Value drivers can also be considered to be components of an organisation's *capability profile*. An organisation's capability reflects how well it can respond to customer (and market) expectations. It suggests that the downstream role of supply chain organisations should be considered from a capability aspect and that the capability response is the aggregate of a specific set of L & SCM value drivers. Christopher (1998) and Harrison and van Hoek (2008) suggest that quality, speed and cost are; "a triad of interconnected goals is almost universal in its desirability", (Christopher); and as; 'hard objectives', (Harrison and van Hoek) because they are easy to measure and relatively obvious to the end-customer'.

*The Economist (*2010*)* conducted a global survey "Aiming Higher – How Manufacturers are Adding Value to their Business". In the report participants' *value drivers* were identified. These included:

- Cost reduction
- Accessing new technologies
- Accessing new markets/customers
- Accessing specialist skills to enable the organisation to focus on the core business
- Increase speed of new product development/time-to-market
- Spreading risk across multiple partners

Respondents suggested these were being addressed by seeking partners or developing or developing closer alliances with their existing partners. The primary purpose of network collaboration is not only to add value to the network (and to individual members) but also to do so for the end-user customer. Clearly there may be trade-off options that occur and an overall network cost reduction may have a number of considerations; it may be counterproductive for one or more the network members and as such will disrupt the balance of the network's profitability/productivity planning and it may also have a negative impact on customer service such that the target end-user may be worse-off. It follows that any decision made should be taken following a review of the 'total' impact on *all* stakeholders.

4.3 Understanding Value Driver Analysis Requires a Multi-disciplinary Approach

Following from discussions with several businesses, Fig. 5 identifies the typical roles of inter-disciplinary activities in developing an understanding of customers' value driver expectations. The *strategic direction* of the organisation and its role

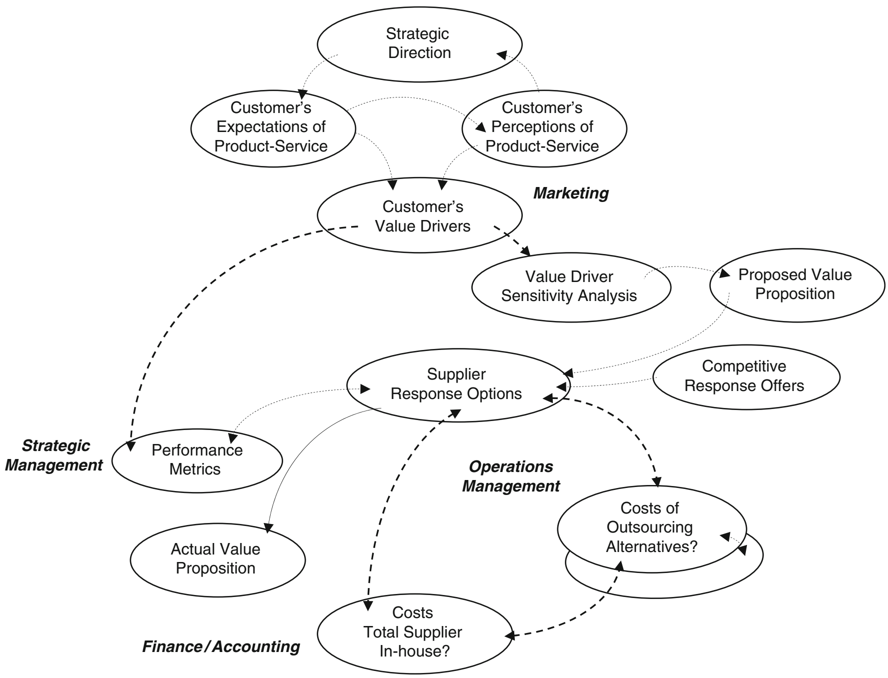


Fig. 5 Using customer expectations to derive value drivers and organisational responses

within a supplier network provides a market opportunity profile for *marketing* to assess market opportunity. *Operations management* can assess the organisational ability to identify the resources required to make a sustainable response, using internal and or external resources, and to contain that response within the budget constraints set by accounting (operating expenses) and finance (return on capital invested).

It follows that meeting customer value expectations and creating differentiation around important value drivers requires close and careful monitoring of the firms immediate customer's operations *and* of the ways and means by which they create value in turn for their customers. ***Marketing** should identify value drivers from the perspective of the customer organisation and **operations management** undertake the role of planning and implementing supplier activities to ensure the implementation*. Essentially it is the responsibility of marketing to provide a profile of the customer 'value-in-use' characteristics. Of particular interest is the rate of flow of product and their service expectations. The demand data that is generated will provide input to *Operations* to plan the logistics management (materials and service flows, information content and service support, and the management of transactions and cash flows) of the required response. For the response to be successful it is essential that *a collaborative* working arrangement be established between marketing and operations. This is particularly necessary for efficient materials and information flows. The proposal that a *value proposition* is used as the vehicle for the liaison role is based upon the premise that it (the value proposition) not only reflects customer expectations but *also* identifies the resource deployment required for success. Operations are tasked with evaluating response alternatives against the organisation's overall strategic and operating plans.

Understanding your customer's value drivers is an essential input into identifying the costs of customer relationship management. Figure 6 illustrates a method of exploring customer value drivers in the context of their resources requirements and the benefits they will deliver to customers. Typically these will be the result of discussions with the customer organisations, suggested above (which is how they were derived). The output from these discussions will aim to quantify the dollar value of successful delivery of customer value and the structure of the network required to make the delivery together with the potential impact on the costs of delivering customer expectations (shown in italics underneath each of the value drivers).

For example *(risk reduction – product-service development)* has become expensive in a number of industries; RD&D and time-to-market is often prolonged by extensive product testing, 3D "printing" is becoming a favoured way of making significant reductions in cost and time. Aircraft power units are leased not sold; they are charged to airlines on the basis of hours flown and serviceability as an alternative to outright purchase as a means of increasing *Fixed capital effectiveness* is improved by introducing ownership alternatives. *Working capital efficiency* can be

Fig. 6 Value drivers that increase customer productivity performance

improved in a number of ways by suppliers; VMI and JIT (and JIT2) programs reduce both the value of inventory holding and the time and amount of inventory required to service customers.

Figure 7 considers and evaluates the alternative delivery options that are available and that create competitive advantage for customers and network members. The responses should be considered from a network membership view and from an end-user perspective. For example, "*Lean Operations Management Improves Customer Competitiveness*" is suggesting that simplifying design of products with manufacturing and downstream activities (maintenance and repairs) in mind can reduce supplier and end-user costs. However this requires an expertise that typically is the province of large organisations as it requires a knowledge of product-service *and* process design. Often it requires the large purchasing volumes of well-known organisations such as Phillips NVwho use their market presence and to purchase materials for their suppliers in order to ensure high quality inputs into their branded products to ensure quality continuity as well as gain a cost advantage. Equally to "*Improve Customer Replenishment Response Time*" has similar considerations; among the options are activities such as VMI (vendor managed inventory) and JIT, and JIT2 both of which are likely to increase costs, JIT because some of the deliveries (based upon deliveries being made to meet specific time intervals) and JIT2 (a facility in which a supplier company provides a staff member to work on site with a customer) can both be expensive to the supplier. And "*Customisation Increases Competitiveness*" suggests there may be benefits from network association as it may encourage the development of specialist activities in the value chain network these may be product and/or service characteristics.

This exercise is useful from a number of aspects. One is that it identifies alternatives and these can be considered from a cost-efficiency perspective by identifying the impact on customer productivity of the incremental per dollar of additional cost on each alternative. Another aspect is the impact on the customer's service offer to end-user customers, and thirdly it is worthwhile to consider the competitive advantage the supplier can create using one of the alternatives available. A fourth issue may be that there is some synergy to found among the responses; for example between 'time' and financial performance.

4.4 Exploring Value Driver Sensitivity

Sensitivity analysis can be added by using the *operating statement* and exploring the impact on both operating productivity and profitability of improvements in the value offer; this is shown as Fig. 8; the revenue and cost items are shown on the left hand side of the diagram while the centre column lists factors the influence changes in these items, on the right hand side the value drivers identified by an activity suggested by figure eight are shown and are linked with the most likely factors. Such an approach does require the cooperation of the network organisation (and ultimately that of the end-user) but assuming this is given a means by which the

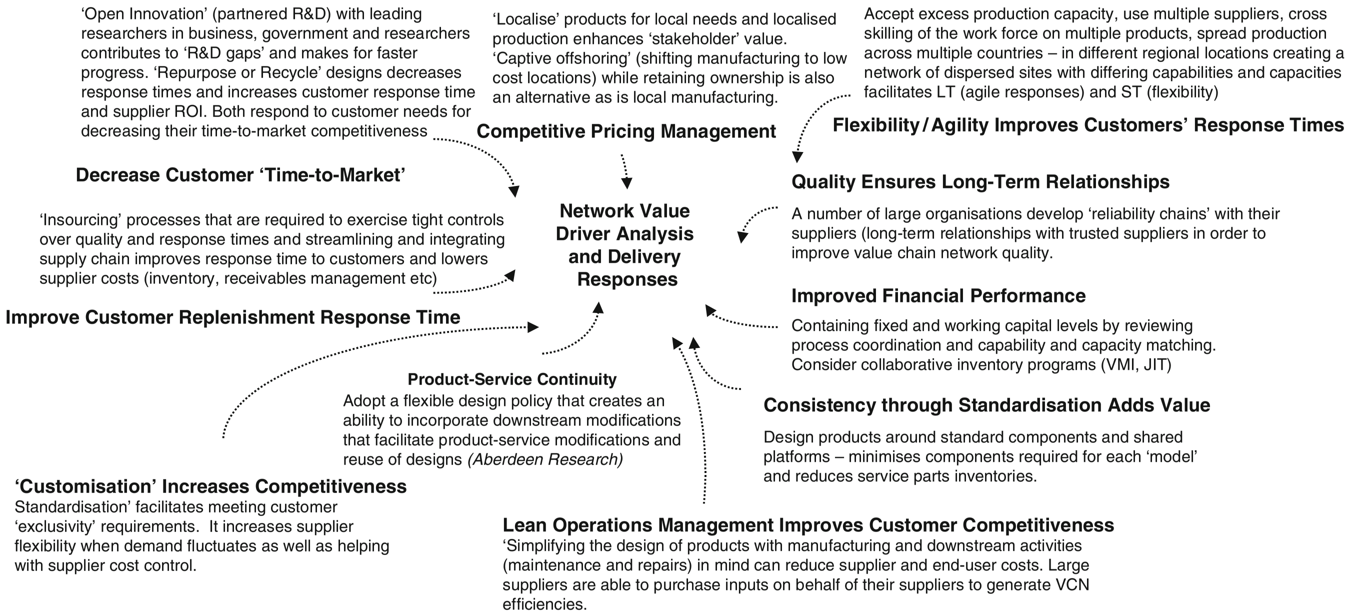


Fig. 7 Value driver analysis and delivery responses: an exercise in managing productivity in the value chain network

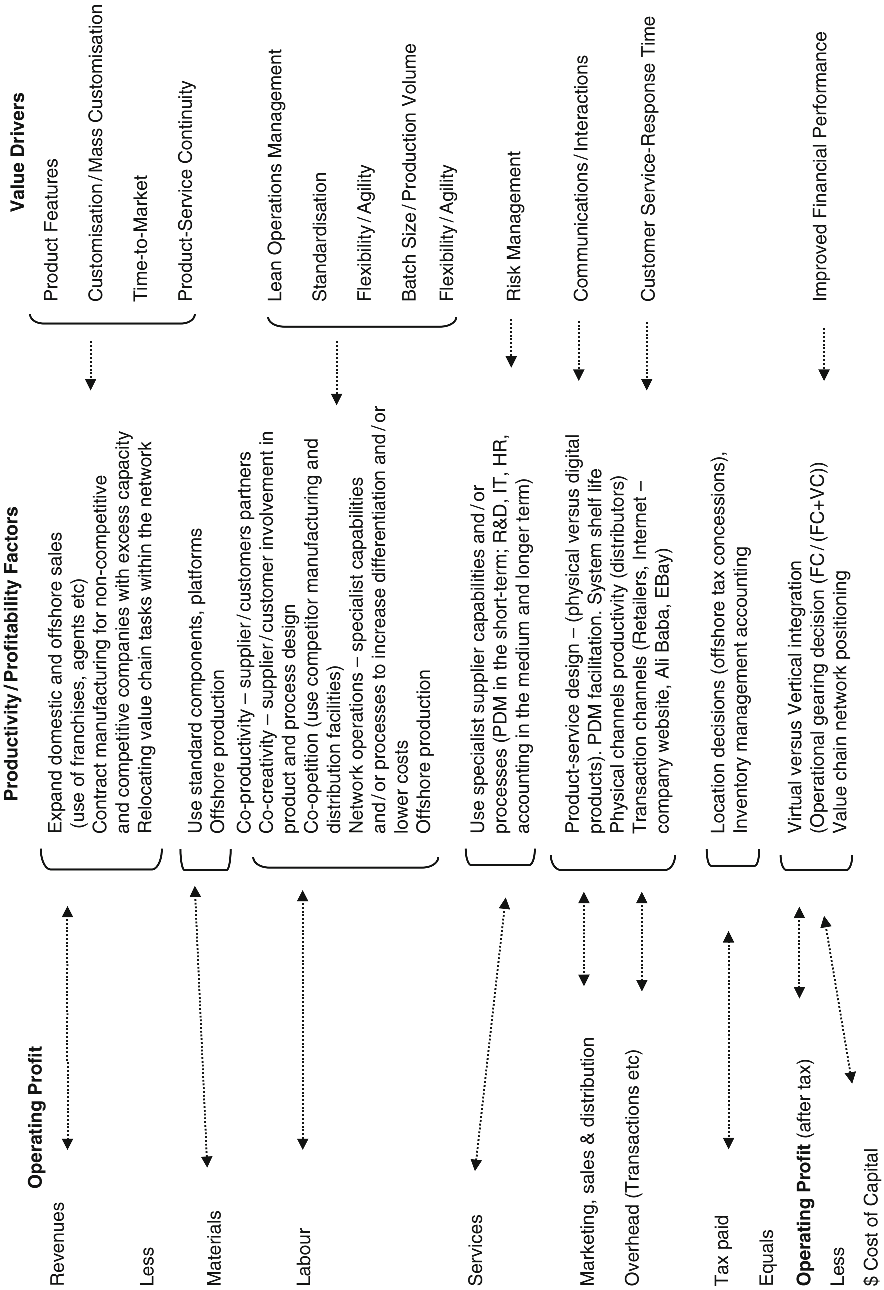


Fig. 8 Using value driver sensitivity analysis to improve operating productivity

companies can collaborate effectively can be seen. Research so far suggests that by understanding the value drivers that have a significant impact on customers' operational performance and responding with an aspect of service or possibly downstream cooperation not only does the customers' productivity and profitability increase but so too does customer loyalty.

The principle of the network structure is mutual profitability and productivity. It follows this is only likely to be realised if the holistic structure of the network is used to construct an inter-organisational approach to identifying and producing a response to the target customer market needs. This principle is not just about managing costs, it also embraces the opportunity to increase revenues. By expanding domestic and offshore sales (using franchises, agents, etc.) and by generating revenues by using excess capacity for contract manufacturing for non-competitive *and* competitive companies both profitability *and* productivity can be increased. This may well be improved upon by taking opportunities to reposition in the value chain network if there is seen to be a "vacancy".

Opportunities to lower *labour and materials costs* can also be explored using this 'model'. Alternatives such as restructuring and/or relocating manufacturing and distribution operations to use capabilities and capacities of all partners should be an on-going task and the potential benefits of *co-productivity* (using supplier/and customer partners' expertise) in alternative business models should be pursued. *Co-creativity* (encouraging supplier/customer involvement in product and process design) often results in efficiencies *and* increased customer satisfaction. *Co-opetition* (using competitors' manufacturing and distribution facilities) is another alternative to lowering capital intensity as well as operating costs. Network operations typically include specialist capabilities and/or processes to increase differentiation and/or lower costs. For example, in the wine cluster areas of the Australian wine industry specialists appear whose roles are to offer services such as processing and bottling product. This can be achieved if the facility is located adjacent to growing and processing and has volume throughput to achieve economies of scale.

4.5 Value Drivers and Cost Drivers and Identifying and Using Customer Facing Processes

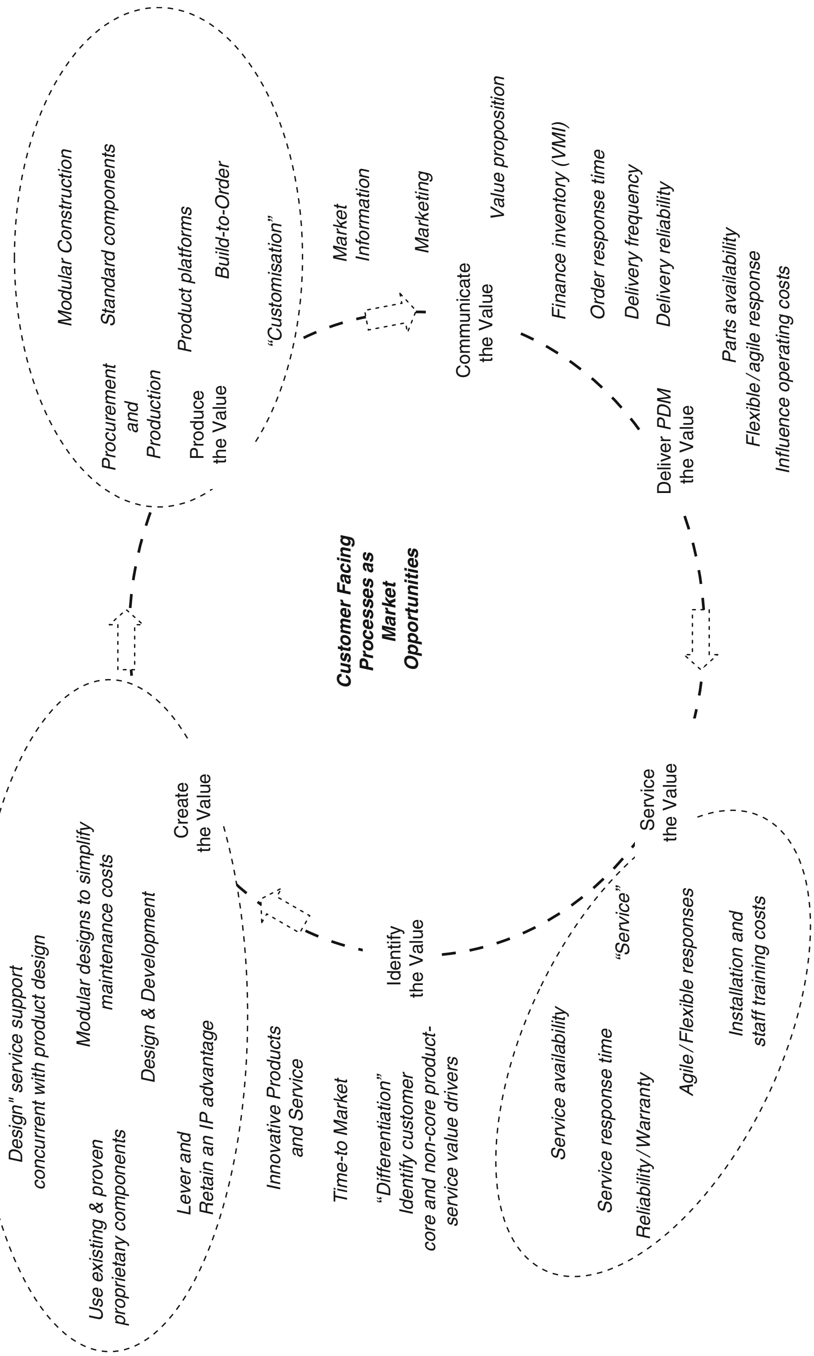
Creating value incurs cost and for many organisations there is a decision to be made concerning the precise relationship between the value delivered to the customer, the value generated for the organisation and its partner stakeholders, and the *cost of creating*, *producing*, *communicating*, *delivering and servicing the value*. It follows that the relationship between value drivers and cost drivers is important. Scott (1998) commented: "Since time immemorial there have been two sorts of activities in companies; those that drive value creation and those that drive unproductive cost." Scott suggests that the harsh reality of globalisation and the accompanying increase in competition has forced most companies into making efficiency gains. However, the persistence of competitive pressures makes the speed of efficiency gains in production and the speed of market responsiveness necessary to compete are increasing. And: "Cost structures are shifting dramatically year by year as new producers come on line and new technologies propel shifts in business processes. Everything is moving faster and will continue to accelerate. Today's competitive "paradigms" will be tomorrow's old hat".

There are a number of implications for value chain structures arising from Scott's comments. Value chain structures are networked organisations and as such do have the flexibility to meet changes either in customer value expectations or in the way in which value is delivered. Meeting value expectations and creating differentiation around important value drivers requires close and careful monitoring of the consumption cycle *and* of the ways and means by which value can be created, produced, communicated and delivered. The application of technology developments (process and product technology as well as information communications technology) is an important aspect of *how*, *who*, *when* and *where* value is delivered. Figure 9a identifies the value processes involved in creating customer satisfaction by identifying *Customer Facing Processes*; processes that have a major impact on customer performance.

There are a number of considerations involved. Clearly the first of these is having identified the value drivers and their *relative importance* to the target customer they must be reviewed within the operating abilities and cost structure of the supplier organisation. If there are any major discrepancies these can be discussed with other network organisations in order to reach an arrangement in which service and costs are acceptable to both the customer and the supply network; this is shown as Figure 9b. On-going research suggests that by using logistics and supply chain management processes to look to improve delivery processes to the customer (costs, time, accuracy and information) each of the "problem" processes was identified and matched with the supply process responses. In one situation the value drivers were identified had considerable leverage on productivity and profitability. The supply response processes were identified and aligned with the value drivers to determine how, if modified, they would improve customer performance *and* what the implications were for supplier costs. Competitor performance was researched in an attempt to identify superior processes and/or cost performance. In this particular instance the solution could be resolved internally, however this may not always be the case. The Phillips example (above), Phillips used their market presence to purchase materials for their suppliers in order to ensure high quality inputs into their branded products that in turn also ensured quality continuity.

Organisations such as Li and Fung (Hong Kong) and the Taiwan computer ODMs know and understand the implications of customer value drivers on the operations response system processes. See Seely-Brown and Hagel (2005). Identifying these relationships at an early stage provides early input into the structure of the operations response system – the essential "customer facing processes" the critical processes are identified at an early stage of the planning, those that are "in-house", that is available within the existing internal structure, can be evaluated for capability and capacity suitability, and system modifications made

a


Customer Facing Processes as Market Opportunities
Create the Value
Design & Development
Design" service support concurrent with product design
Modular designs to simplify maintenance costs
Use existing & proven proprietary components
Lever and Retain an IP advantage
Procurement and Production
Produce the Value
Modular Construction
Standard components
Product platforms
Build-to-Order
"Customisation"
Communicate the Value
Market Information
Marketing
Value proposition
Deliver PDM the Value
Finance inventory (VMI)
Order response time
Delivery frequency
Delivery reliability
Parts availability
Flexible/agile response
Influence operating costs
Service the Value
"Service"
Service availability
Service response time
Reliability/Warranty
Agile/Flexible responses
Installation and staff training costs
Identify the Value
Innovative Products and Service
Time-to Market
"Differentiation" Identify customer core and non-core product-service value drivers

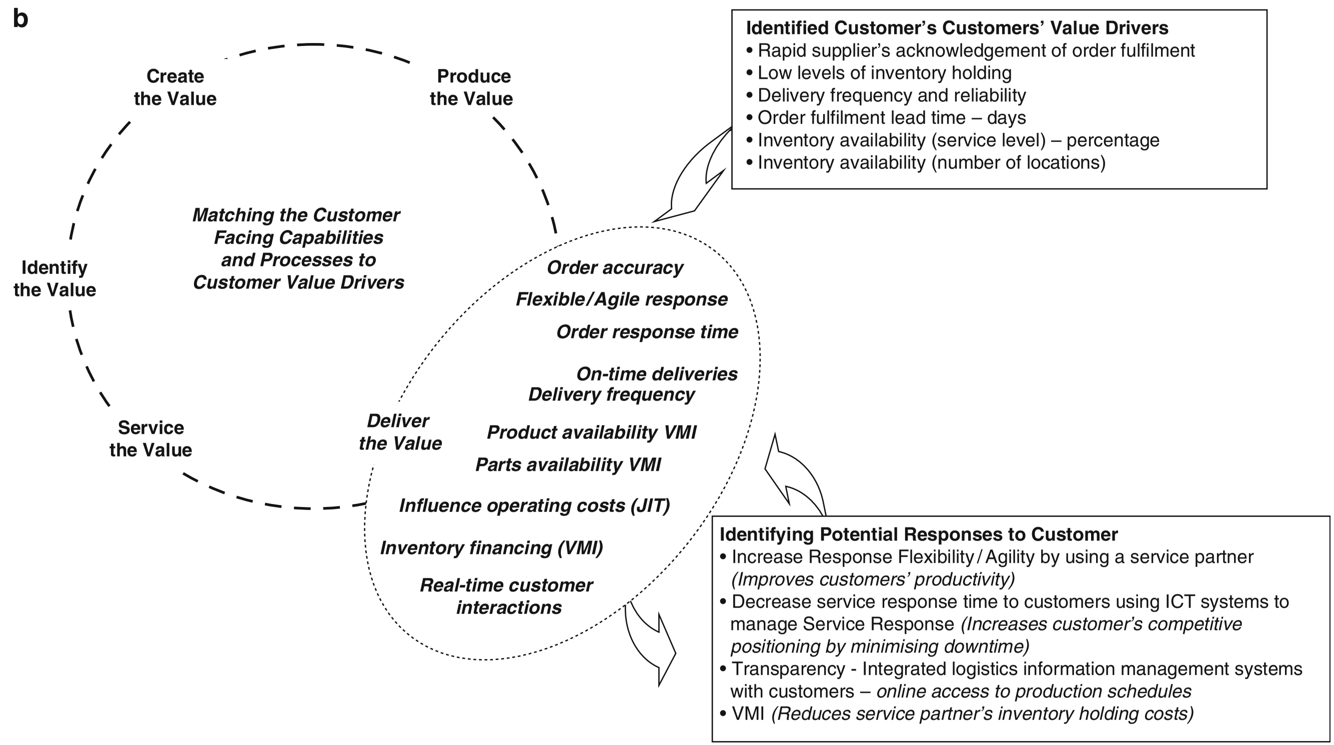


Fig. 9 (**a**) Identifying important customer facing processes that add customer value. (**b**) Matching customer value drivers with relevant processes

where necessary; often more efficient external solutions may be found. This initial analysis extends the response decision beyond *competitive necessity* towards developing *competitive advantage*, perhaps into a position of *sustainable competitive advantage*. There are also two other influences that need to be addressed. One concern is the increasing level of financial accountability that is being placed on management and the other is the impact of resources conservation awareness.

5 Performance Management: Profitability and Productivity Measurement – A Possibility?

Stern et al. (1996) introduced EVA (economic value added), a concept very similar to Kay's (1993) added value but deduct taxation from the result. *EVA is net operating profit after tax (NOPAT) less a capital charge for the invested capital employed in the business*. EVA is arguably a short-term measure of performance as it is based upon short-term performance. The inclusion of tax in the 'equation' may reflect operational decisions concerning manufacturing and for this reason should be included when making competitive comparisons. EVA in this context includes depreciation of capital assets and also provides for a 'reasonable' return on invested capital; it is the economists' notion of *economic profit* (or residual income). Calculated this way added value is *less than* operating profit (NOPAT.

Value chain networks are built upon the understanding and management belief in collaborative planning, forecasting and management of inter-organisational response to market opportunities with shared resources, responsibilities, and rewards. This raises the important topic of performance management and measurement. Figure 10 uses the EVA concept (introduced in Chap. 2) to measure organisational and network performance. It will be remembered that EVA uses a measure of the capital used to create an output for a specified period of time and this differs to the accounting measure of operating profit that uses depreciation as the "cost of capital"; this is an accounting simplification based upon tax minimisation. Figure ten illustrates the role of the value chain 'integrator in which VCN roles and tasks are agreed (and often changes to meet changes in customer expectations and/or changes in available capabilities and processes) that changes the network's ability to increase profitability and/or productivity. In Figure ten this is suggested with the broken line members suggesting a change in role or tasks or perhaps, an alternative member being introduced into the value chain network.

It is interesting to note that economic profit is used by management consulting organisations to focus their clients' attention on the "real" impact of profitability. George (2010) discusses an experience in which his client company, a hydraulic hose company, several years ago found itself operating at a negative 2 percentage economic profit. "Management didn't understand that their lead time was having a negative impact on the business – a situation aggravated by the poor quality products that were frequently being shipped to customers". In less than 2 years,

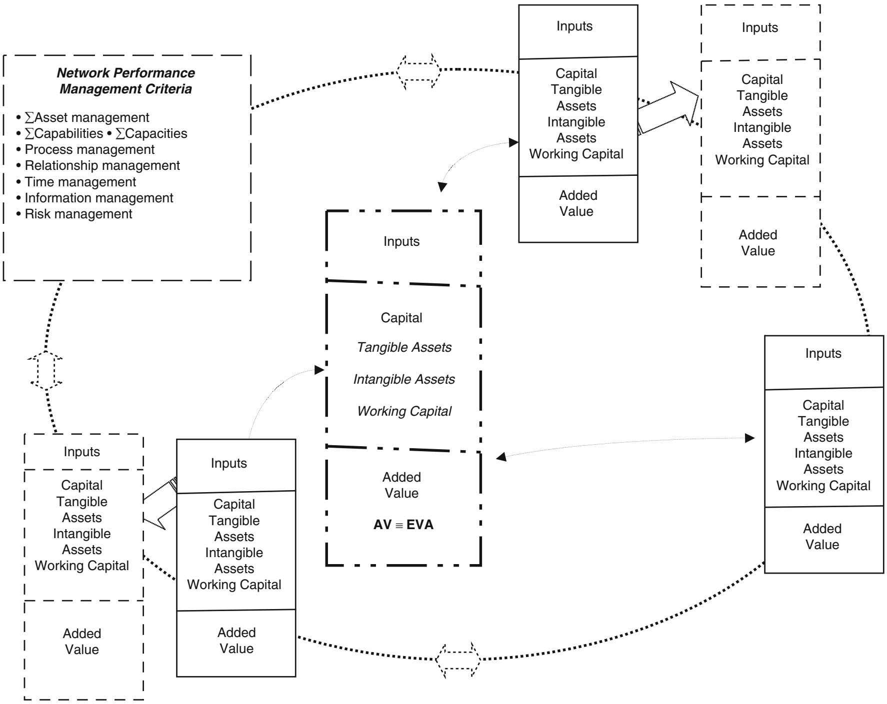


Fig. 10 VCN performance management: increasing the aggregate added value

the company turned the situation around going from 2 percentage economic profit to a positive 21 percentage economic profit. They focused on reducing waste across and between functions to realize cost reduction and enable competitive advantage through alignment on enterprise speed and agility. To enable such a turnaround the company looked beyond process and rationalized customers and offerings that were not contributing to value creation.

Research so far suggests that a service partnership or partnerships is likely to form part of the solution to the current problem and as such, the overall network benefits become an important consideration. Young David and O'Byrne (2001) identified the wide role of EVA with the comment: "At its most basic, EVA is a measure of performance, but it would be a mistake to limit its role in this way. It can also serve as the centrepiece of a strategy implementation process". These they identify as:

- Strategic planning
- Capital allocation
- Operating budgeting
- Performance measurement
- Management compensation
- Internal communication
- External communication

6 Concluding Comments

The dynamic business environment outlined here offers rewarding opportunities to organisations who organise and work their value chain networks effectively (strategically) and efficiently (operationally). It is interesting to note that industry practitioners are developing (and applying) inter-industry as well as inter-organisational processes successfully. One example is that of Minuteclinic, with its application of quick service auto-maintenance processes to healthcare. MinuteClinic has added a value adding component in the healthcare value chain network by introducing a complementary component – not a service that is directly competitive and threatening to others. MinuteClinic offers a relatively low-cost, conveniently accessible method of identifying and treating a range of common ailments. Champy (2008) argues; "you don't need a fully trained mechanic to change the oil in your car"; it follows that in many healthcare situations a fully trained MD is not required to attend to minor healthcare problems. MinuteClinic operates a kiosk based service (usually based in shopping malls) that is open seven days for a total of 72 h. The clinics clearly post the ailments that can be treated together with fees applicable. The kiosks are staffed by qualified nurses who are licensed to prescribe drugs. Each kiosk has an on call physician to whom the nurse can refer in cases of doubt. Treatment typically takes 10–15 min. If the waiting time is likely to exceed 5 min patients are given an electronic pager that informs them of their appointment.

Stephen Mills (2009), Chair of the Australian Business Foundation, gave a timely reminder of the somewhat confused perspectives that exist concerning what productivity actually is. Mills argues that Australian industry requires; "a greater ability to absorb and to apply the knowledge we already have." He suggests that productivity does not rely solely upon R&D expenditures; rather it is about finding solutions to problems by using innovative approaches. Mills' contribution suggests a much needed focus on *process innovation* in attempt at increasing productivity: And; "Rather than recognising innovation as knowledge sharing and collaboration across the value chain most commentators have fallen back into traditional postures on either side of the old divide separating industry and research."

The value chain concept can provide opportunity to increase productivity *and* profitability.

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The Role of Decoupling Points in Value Chain Management

Jan Olhager

Abstract All supply chains are not the same. A key factor that affects the design and management of a value chain is the position of the customer order decoupling point; some products are produced to order (e.g. configured to particular customer needs) while others are produced to stock (typically standard products). The customer order decoupling point (CODP) identifies the point in the material flow where the product is linked to a specific customer. This paper discusses the impact of having the decoupling point at different positions, and the distinguishing features for value chain operations upstream the decoupling point (i.e. towards the supplier) versus those downstream the decoupling point (i.e. towards the ultimate customer). Based on these differences, we explore the implication of the CODP on the modelling of value.

Keywords Decoupling point • Value • Value chain management

1 Introduction

In order to compete successfully, operations in any type of firm need to be strategically aligned to the market requirements. This concerns all aspects and operations of the value chain. The customer order decoupling point (CODP) is gaining attention as an important factor in the design and management of manufacturing operations as well as supply chains. The CODP is the point in the material flow where the product is tied to a specific customer order; the basic choices being make-to-stock, assemble-to-order, make-to-order, and engineer-to-order. As a rule, the CODP coincides with the most important stock point, from where the customer order process starts. From the value chain perspective, there is

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_2,

typically one dominant CODP along the material flow of the value chain. From a company perspective, the CODP can be positioned inside their manufacturing operations or it can be positioned at the suppliers (first tier or even further upstream in the value chain), at the interface with the supplier (raw material inventory), at the border towards the customers (at some finished goods inventory), or even further downstream in the supply chain.

This paper investigates the role of the CODP in value chain management. First, the related literature is reviewed. Then, some distinguishing features are summarized. These two sections serve to establish the fundamental differences between upstream and downstream operations relative to the CODP. Finally, we explore the implications of the CODP on the modelling of value.

2 Related Literature

2.1 The Customer Order Decoupling Point

The CODP is traditionally defined as the point in the value chain for a product, where the product is linked to a specific customer order. Sometimes the CODP is called the order penetration point; cf. Sharman (1984) and Olhager (2003). Different manufacturing situations such as make-to-stock (MTS), assemble-to-order (ATO), make-to-order (MTO) and engineer-to-order (ETO) all relate to different positions of the CODP; cf. Fig. 1. The CODP thus divides the operations stages that are forecast-driven (upstream of the CODP) from those that are customer order-driven (the CODP and downstream). The CODP is also the last point at which inventory is held (Sharman 1984). Thus, the inventory at the CODP is a strategic stock-point since delivery promises are based on the stock availability at the CODP and the lead times and capacity availability for the customer order-driven activities downstream the CODP (Olhager 2003).

The literature on CODP is growing (Olhager 2010). There is a strong consensus among the literature on CODP in that the operations upstream are significantly different than those downstream, based on the fact that the upstream material flow is

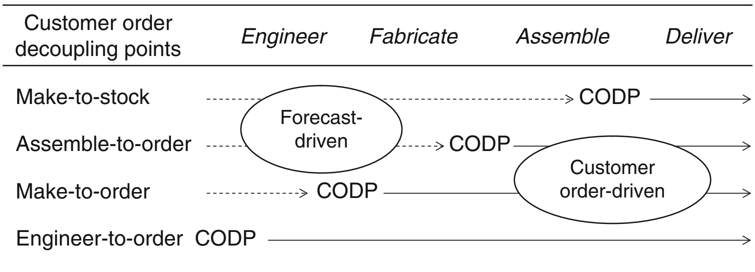

Fig. 1 Different customer order decoupling points (Based on Sharman 1984)

forecast-driven, whereas real customer orders dominate downstream. This has implications for many aspects of the manufacturing value chain. Areas that have been treated in the literature include operations strategy (Olhager and Östlund 1990; and Olhager 2003), logistics systems (Hoekstra and Romme 1992), manufacturing planning and production control (Giesberts and van der Tang 1992; Van der Vlist et al. 1997; and Olhager and Wikner 1998, 2000), manufacturing focus (Hallgren and Olhager 2006), and supply chain planning (Olhager 2010). Other papers have treated the CODP more generally for a certain area of application, such as the Finnish paper and pulp industry (Lehtonen 1999) and the Dutch food industry (van Donk 2001).

2.2 Make-to-Stock Versus Make-to-Order

From a material flow perspective, the four situations in Fig. 1 can be reduced to three, i.e. MTS, ATO, and MTO, since MTO fully includes ETO with respect to the material flow. MTS includes all options regarding keeping inventory in the distribution system; either at distributors, wholesalers or retailers. In all these environments, the product is produced to stock with respect to the form; however, they may differ in terms of time and space relative the ultimate customer. An individual plant may well have products in all categories. Different products being delivered in an ATO fashion do not necessarily have to have the CODP in the same position. What they have in common is that they have an internal CODP, which makes the internal value chain a mix of MTS and MTO; cf. Fig. 2.

Thus, there are two fundamental sections in a material flow: MTS and MTO. The choice of MTS versus MTO is typically a natural and clear-cut one in practice, and the differences and consequences are usually well understood by manufacturing and supply chain managers. For example, the specialty chemical firm Rohm and Haas separated the products into MTS and MTO categories based on demand volume and variability (D'Alessandro and Baveja 2000).

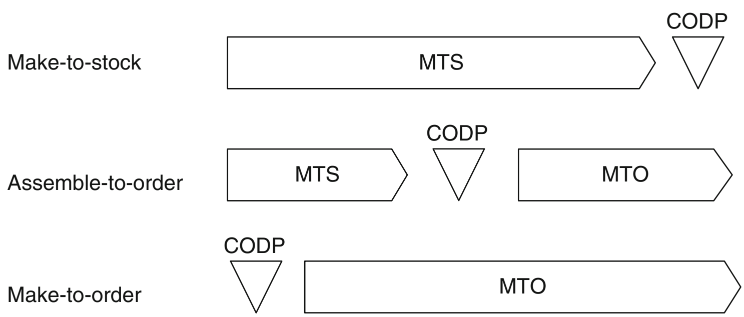

Fig. 2 The CODP partitions the process into MTS upstream and MTO downstream

The Berry and Hill (1992) model for linking manufacturing planning and control approaches to market and product characteristics explicitly uses MTS, ATO, and MTO as choices for the master planning level. MTO should be selected for special products with wide range and low individual product volume per period, and MTS for standard products with predetermined and narrow range and high volume per period (Berry and Hill 1992). This framework has been tested empirically in Olhager and Selldin (2007), and product range was found to be a significant driver of the positioning of the CODP, with a subsequent significant impact on product mix flexibility performance.

The impact of e-business on manufacturing strategy decisions was explored by Olhager and Rudberg (2003), in a study of seven Swedish manufacturing companies. The results showed that e-business interfaces with customers were beneficial to MTO operations in terms of improved delivery lead time and cost performance. However, it had little impact on MTS operations, since the product is already produced and is available for delivery to the customer.

2.3 Lean Versus Agile

One literature stream, initiated by research by the Cardiff group (e.g. Naylor et al. 1999; Mason-Jones et al. 2000; and Aitken et al. 2002), distinguishes between lean and agile supply chains using the CODP as the divider between lean and agile operations in manufacturing or supply chains. A lean supply chain should be applied upstream the CODP, while an agile supply chain would be more suitable for downstream operations. This is the core idea of the “leagility” approach. The distinction between lean and agile has been tested empirically concerning drivers and performance outcomes (Hallgren and Olhager 2009). They found that lean is associated with a cost leadership strategy and cost performance, while agile is associated with a differentiation strategy and flexibility performance. Another aspect of the “leagile” approach is the recognition of an information decoupling point (Mason-Jones and Towill 1999). The underlying rationale is that the feedback of market information does not necessarily have to stop at the (material flow related) CODP, but can be forwarded further upstream to provide advance planning information. Still, in practice, the information and material decoupling points most often coincide.

2.4 Related Models

The product-process matrix by Hayes and Wheelwright (1984) can be complemented by the CODP. Low volume, low standardization, one-of-a-kind products need to be produced in an ETO/MTO fashion focussing on flexibility and quality, and the CODP position gradually shifts to the finished goods inventory (possibly extended to include distribution inventories) for high-volume, high standardization, commodity products focussing on dependability and cost at the other end of the product characteristics continuum.

The product profiling concept developed by Hill (2000) can also be related to CODP positions. According to the product profile table (Hill 2000), standard products with very narrow range win orders on price, wherefore the key manufacturing task is to provide low-cost production (i.e. applicable to MTS operations and upstream a CODP), whereas special products in wide range win orders based on delivery speed and unique design capability, wherefore manufacturing has to meet specifications and delivery schedules, which requires high flexibility (i.e. applicable to MTO operations and downstream a CODP).

The model by Fisher (1997) for choosing the right supply chain for products includes a distinction between two product types and two supply chain types. He made a distinction between functional and innovative products, and between physically efficient and market responsive supply chains. Functional products characterized by e.g. a steady demand pattern and long product life cycles should be managed in a physically efficient supply chain that focuses on cost minimization and high utilization of resources, whereas innovative products with demand volatility and short life cycles should be transformed through a market-responsive supply chain that has extra capacity, capability of market demand information processing, and that is more flexible. This model has been tested empirically (Selldin and Olhager 2007), finding some support for this model. It should be noted that the products that are considered in this model are business-to-consumer products that are made to stock. Still, the core ideas of this model can be related to the CODP, such that the characteristics of the physically efficient supply chain can be considered applicable to operations upstream the CODP, while the characteristics of the market-responsive supply chain can be considered useful for downstream operations (Olhager et al. 2006).

Another related model is the supply chain operations reference (SCOR) model (Supply Chain Council 2008). The three basic processes – source, make, and deliver – in the SCOR model are differentiated for make-to-stock, make-to-order, and engineer-to-order products. Thus, the SCOR model acknowledges that the position of the customer order decoupling point has an impact on the design of operations processes.

3 Distinguishing Features

Based on the review of the related literature we can conclude that there are indeed substantial differences between operations and activities upstream the CODP and those downstream the CODP. In Table 1, we summarize some key aspects of what distinguishes the operations upstream the CODP from those downstream.

Table 1 Distinguishing features of operations and activities upstream versus downstream the CODP (Based on Hallgren and Olhager 2006)

Features	MTS and upstream the CODP	MTO and downstream the CODP
Product characteristics	Standard components, high volumes, predictable demand	Customised, high variety, wide range, unpredictable demand
Order winners	Price	Delivery speed, flexibility
Qualifiers	Quality, delivery reliability	Quality, delivery reliability
Supply chain design	Physically efficient	Market responsive
Lean versus agile	Lean	Agile
Manufacturing task	Provide low cost manufacturing, maintain high stock availability at the CODP	Manufacture to customer specification, achieve short and reliable lead times
Key properties	Productivity	Flexibility
Improvement priorities	Cost reduction	Lead time reduction

4 Implications of the CODP on the Modelling of Value

4.1 Value Perceptions

In general, the customer value function is based on the perception of a variety of criteria related to the competitive capabilities of the value offering firm. Many criteria are manufacturing-based, but other criteria may be included.

$$\text{Value} = \mathrm{f}(\mathrm{Q},\ \mathrm{D},\ \mathrm{P},\ \mathrm{F},\ \mathrm{X}),$$

where Q = quality (conformance to specifications), D = delivery (speed and reliability), P = price, F = flexibility (volume, product mix, and design – in support of customization and product range), and X = other aspects. Other non-manufacturing related aspects may include design, brand, image, etc.

In MTS environments, price is typically the dominant criteria and acts as a major order winner. Quality and delivery are typical market qualifiers, while flexibility typically is not required at all. Using bold to denote order winner, and italics to denote qualifiers, the value perception of MTS operations can be depicted as:

$$\text{Value (MTS)} = \mathrm{f}(Q, D,\ \mathbf{P},\ \mathrm{F},\ \mathrm{X}),$$

In MTO environments, the important competitive criteria are typically based on quality, delivery and flexibility. The order winner is typically related to some aspect of flexibility, while quality and delivery are typical market qualifiers. Price may be a qualifier, but for some products price is not really the issue. Delivery speed may appear as part of the order winning criteria. Non-manufacturing related aspects may also contribute to order winning or qualifying.

$$\text{Value (MTO)} = \mathrm{f}(Q, D,\ \mathrm{P},\ \mathbf{F}, X),$$

Thus, the perception of what creates value is very different for MTS and MTO products in general.

4.2 Deployment of Perceived Value

The value perception differences between MTS and MTO products must be taken into account when designing and managing value chains. In particular, the perceived value is different on the two sides of the CODP. Consequently, the deployment of the value perception in the market is only relevant to the CODP. Upstream the CODP, the value has to be related to MTS products, for which MTO-based value perceptions are not valid. This is illustrated in Fig. 3.

4.3 The Impact of Profit Margin

A key aspect of the value perception for the manufacturer is the profit margin of the products sold to the market. A low margin corresponds to a competitive market place with many competitors, which is common for mature products that typically are produced to stock. On the other hand, a high margin is more typical for products that are customized or where the product range is wide, offering the customer a

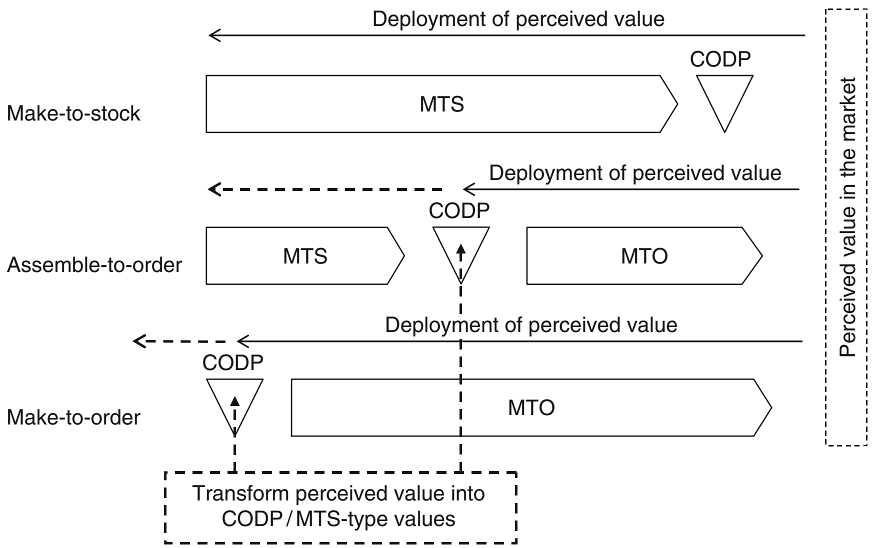

Fig. 3 Deployment of perceived value with respect to the position of the CODP

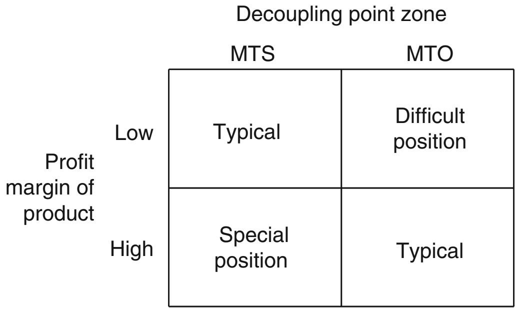

Fig. 4 Differences in profit margin with respect to the CODP

wider choice. Figure 4 illustrates the common relationships between profit margin and the CODP. Even though the figure depicts the relationships for end products in MTS and MTO operations, the results can be translated into operations upstream and downstream the CODP. Consequently, the profit margin of components and items upstream the CODP is typically low (since these have sufficiently high volumes to allow for being produced to stock), while parts and end products downstream the CODP have higher profit margins (since these include some element of customization).

Figure 4 includes two "untypical" positions that are possible in practice. In particular, the special position of high profit margin in MTS operations is possible for products where value is built largely on product innovation, design or brand name. Examples of such products are pharmaceuticals, fashion clothes, and some luxury items. The last quadrant with low profit margin in MTO operations is a difficult position. Since MTO operations often have some excess capacity to deal with unstable demand, the profit margin can easily be wiped out if demand is not sufficient with respect to the capacity level. This may be case for some subcontractors that rely heavily on a steady stream of orders from their customers in order to stay profitable.

The profit margin is indicative of the relationship between value (for the customer), price and cost (for the manufacturer). For a competitive product the following relationship must hold:

$$\text{Value} > \text{price} > \text{cost}.$$

If price exceeds the value perceived by the customer, he or she will go elsewhere. If cost exceeds the price, the manufacturer will most likely go out of business in due course. In low-margin operations, the focus is to make sure that the margin stays positive, and avoid unnecessary costs. In high-margin operations, the manufacturer continuously strives to keep the margin or improve it, by product innovation, product design or building the brand name. Figure 5 illustrates these relationships.

MTS operations are typically cost-conscious, having to focus on cost control and measure cost performance to maintain the profit margin (small, but positive). MTO

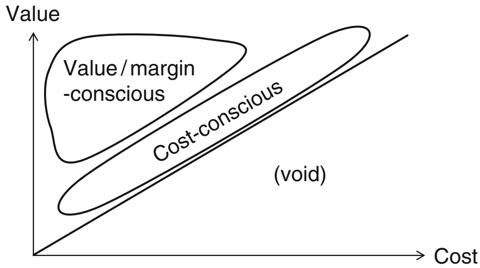

Fig. 5 Different types of focus with respect to the relationships among value, price and cost

Table 2 Some value-related aspects relative to the CODP

Aspect	MTS and upstream the CODP	MTO and downstream the CODP
Value added	Low	High
Profit focus	Cost performance	Margin/value contribution
Profitability generation	Through cost reduction	Through margins and sales
Pricing model	"Cost plus" (restricted by market price)	Value-based
Operational problem	Cost control	Market supply

operations have a wider scope of options in creating new complementary value-cost relationships.

4.4 Some Implications of CODP on the Modelling of Value

Based on the exploratory discussion of the value concept in MTS versus MTO operations it can be concluded that there are substantial differences. In Table 2, some key aspects are summarized that distinguishes the operations upstream the CODP from those downstream.

5 Concluding Remarks

This paper investigated the role of the CODP for value chain management. The CODP has a key role in developing and managing value chains in that value chain operations upstream the CODP perceive value differently than those downstream the CODP. As a consequence, the two parts around the CODP should be designed and managed differently in order to support the value creation at each respective stage.

These results are generally applicable to value chain operations. For firms where there is only one type of decoupling situation, i.e. only MTO or only MTS, the firm can apply a single approach for the value chain. However, most firms tend to have a mix of MTO and MTS products, wherefore different approaches have to be applied for different parts of the firm. Also, in ATO situations the two types of approaches need to be applied to different parts of the value chain for a single product line. The fact that the entire value chain is not aligned towards one goal (i.e. the competitive priorities of the ultimate consumer) is not a dilemma per se. The important issue is to fit the approach to the task of each respective material flow – both upstream and downstream the CODP.

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Evaluating the Effectiveness of Experiential Learning for Motivating Value Chain Stakeholders to Adopt New Ways of Capturing Value

Martin Gooch

Abstract Value chain management, where businesses situated along the value chain purposely work together to achieve outcomes that would not otherwise be possible, is proving a valid way of securing competitive advantage in a rapidly changing business environment. This research examines the effectiveness of experiential workshops, structured to reflect theories of adult learning and value chain management, for motivating managers of agri-food businesses to adopt value chain management approaches. The results show that experiential workshops are an effective means of motivating managers to acquire the knowledge necessary to proactively develop closer relationships with other businesses, leading in turn to the ability to capture value through non-traditional means. An average of 14 months after attending the workshop, the majority of managers from commercial businesses had changed how they managed their businesses. A number of the involved businesses had significantly improved their performance.

Keywords Adult learning • Agri-food management • Culture • Experiential workshops • Innovation • Mindsets

1 Introduction

In a rapidly changing business environment, typified by technological innovation, industry consolidation, deregulation, and changing consumer demands, new ways must be found to capture and create value (Boehlje 1999; Senge 1997; Senge et al. 2006). Value chain management (VCM), the deliberate decision by members of a value chain to combine their resources to improve competitiveness, is proving a powerful strategic approach that enables organizations to adapt to a rapidly

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_3,

changing business environment (Dunne 2008; Fearne 2007; Taylor 2006). This comes from how, in developing closer strategic relationships with customers and suppliers, businesses acquire the ability to learn and adapt more effectively than if operating as separate organizations (EFFP 2005; Senge et al. 2006).

Closely aligned value chains are however forming slower in the agri-food industry compared to IT and automotive (Cowan 2007; Fearne 2007; Fortescue 2006). A primary reason for the slow rate at which VCM is being adopted by businesses operating in the agri-food industry is said to be a function of the extent to which agri-business managers are unable to communicate effectively with businesses operating at different levels along the value chain (Taylor 2006; Morgan 2007). This results in the agri-food industry possessing a tendency to look to the past for ways it can compete in the future (Boehlje 1999; Oram 2008). It also leads to the continuation of entrenched adversarial business relationships (EFFP 2004; Johnson 2007), and perpetuates business models unsuited to enabling businesses to compete in a rapidly changing business environment (EFFP 2004; Fortescue 2006; Ison 2000b). It also leads to the continuation of mindsets unsuited to the task of forming and managing closely-aligned value chains (Boehlje and Lins 2008; Oram 2008).

A mind-set (otherwise known as a mental model) is a tightly bound network of ideas, values and beliefs that determine individuals' attitudes towards the surrounding environment (Moon 2004; Jarvis 2004). They determine an individual's perception towards other individuals, businesses, and the systems within which they currently exist (Eckert and Bell 2005; Fearne 1998; Johnson 2007). Mindsets also influence an individual's preparedness and ability to learn about a given topic or how they might purposefully alter their behaviour to achieve a desired outcome (Fell and Russell 2000; Johnson 2007). They also determine individuals' attitudes and behaviour towards others (Argyris 1995; Eckert and Bell 2005). The ability, therefore, to act upon new value capturing opportunities relies on those involved possessing the necessary mindsets (Barrat 2004; Whipple and Frankel 2000), particularly in circumstances where adversarial relationships exist between buyers and suppliers (Johnson 2007; Spekman et al. 2002).

Motivating the agri-food industry to embrace the VCM business model on a wider scale than presently exists is therefore dependent on encouraging appropriate changes in the mindsets of individuals operating in the agri-food industry (Eckert and Bell 2005; Fulton et al. 2003). Purposeful changes in mind-set can only occur if individuals are motivated to learn, then use the acquired knowledge to critically evaluate the values, assumptions and beliefs which together shape their perceptions of the world around them (Kolb 1984; Wlodkowski 2008; Zull 2002). Compared to traditional teaching methods, experiential workshops have been proposed as an effective means for motivating adults to reflect on the suitability of their present mindsets, potentially leading to purposeful changes in attitude and behaviour (Kolb 1984; Moon 2004). They have also been proposed as an effective means for instilling in individuals tacit knowledge (Jarvis 2004; Knowles et al. 2005), which is more important than explicit knowledge for motivating and enabling individuals to successfully form, then manage, closely aligned value chains (Johnson 2007; Senge et al. 2006).

2 Motivating Changes in Behaviour

Fulton et al. (2003:74) state that little has been published on "identify(ing) the keys to communicating value chain information" to agri-business managers in a manner that leads to long term changes in attitude and behaviour. Motivating individuals to learn is a challenging endeavour (de Bono 1999; Knowles et al. 2005; Senge 1997). It is even more challenging to motivate adults to translate what they learned into purposeful action (Goleman 2000; Ison et al. 2000; Jarvis 2004).

Motivating adults to learn, then purposely act on what they learned relies on presenting information in a manner that leads them to perceive that it possesses value, for example, through showing how it will enable them to solve a problem that they face (Knowles et al. 2005; Moon 2004). It also relies on presenting the information in a way that appeals to their senses (Zull 2002; Wlodkowski 2008).

Motivating adults to purposefully change their behaviour relies on creating a sense of urgency about the need to change, for example, sensing that they may miss out on an opportunity which will not be repeated; or that they will be left in a vulnerable position compared to those that do change (Hamel 2002; Moon 2004; Rother and Shook 2003). Additionally, though an individual may possess knowledge that suggests a need exists to change their attitude and behaviour, they will not do so unless they also possess a mind-set that supports the desire and ability to change (Knowles et al. 2005; Zull 2002). This can lead to them possessing a greater willingness to embrace business models not traditionally associated with the agri-food industry (Fell and Russell 2000; Ison et al. 2000; Johnson 2007).

To facilitate a purposeful change in mind-set, an individual must be willing and able to learn (Jarvis 2004; Moon 2004; Wlodkowski 2008). Effective learning occurs when an individual is prepared to critically reflect on whether the ideas, values and beliefs that underpin their current mindsets are appropriate, given the knowledge they acquired through the learning event (Kolb 1984; Moon 2004). Known as double loop learning, motivating an individual to critically evaluate then modify their current ideas, values and beliefs in the light of new knowledge is critical to motivating purposeful changes in their attitudes and behaviour (Argyris 1995; Senge 1997; Moon 2004; Zull 2002). Double loop learning is more likely to occur when the learning experience is able to establish an emotive bond between the individual, the topic and how they might apply the acquired knowledge to solve a problem(s) that they face (Gross Davis 1993; Jarvis 2004).

3 Experiential Workshops

Argyris (1995), Zull (2002) and Moon (2004) are among the many researchers who say that experiential workshops are an effective way of facilitating double loop learning. Argyris (1995) states that this is best achieved through providing individuals with generalizations on which they reflect as they go about their daily tasks.

Experiential learning differs from traditional learning in that the teacher is not viewed as being superior to the students (Zull 2002; Moon 2004); nor are they viewed as a conduit through which the information is communicated to students (Jarvis 2004; Knowles et al. 2005). Experiential learning utilizes a facilitator who is equal in status to the students. The facilitator's primary role is to encourage the students to make a direct connection to the material presented, through facilitating a discussion on how they might benefit by applying the knowledge in their own situation. This is achieved through encouraging meaningful interaction between peers, each of whom will possess a different perspective of what they witnessed and how they might apply the resulting insights to their own situation (Ison and Russell 2000a; Fell and Russell 2000; Moon 2004). In so doing, the participants are able to gain a greater understanding of how relationships that exist between the ideas presented, individuals or groups, and the wider environment might influence their future opportunities (Fell and Russell 2000a; Jarvis 2004; Zull 2002). This same process leads to a stronger emotional connection being established between the individual, the topic, and how they might act upon the knowledge in the context of their own situation and prior experience.

Figure 1 shows Fell and Russell's (2000) description of how, through sharing experiences and understanding about how the perspectives of others compare to

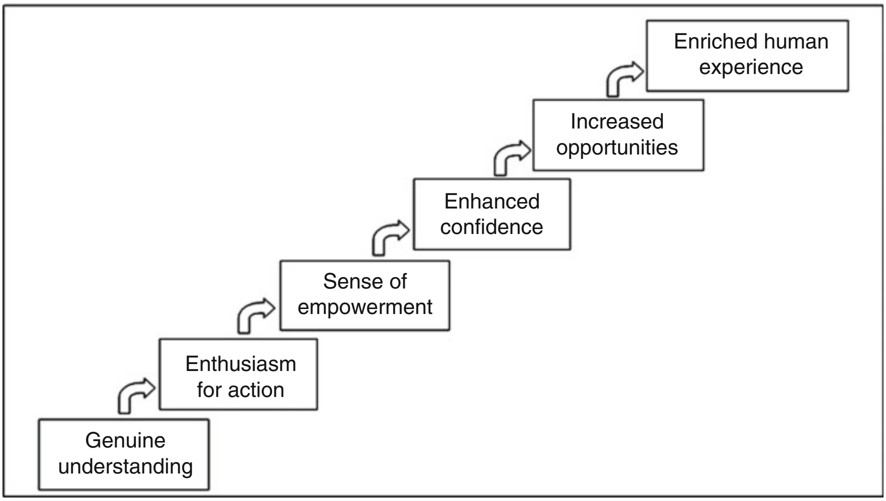

Fig. 1 Role of motivation in developing increasingly sophisticated problem-solving skills

their own, agri-business managers can become less focused on the mechanics of how the present system works and the outcomes that it produces. Instead, their focus shifts towards the future. This leads to them developing a common language. It also leads to changes in how individuals perceive each other and the system within which they interact. This results in a powerful emotional connection developing between the individuals, particularly in terms of how they could together redesign the present system to achieve the outcomes they desire. This sense of aspiration motivates individuals to continue learning together, and leading to the participants possessing the desire and ability to embrace new and innovative approaches to capturing value.

4 Research

The potential for utilizing experiential learning techniques to facilitate purposeful changes in the attitudes and behaviour of agri-business managers is not well documented (Dart et al. 1998; Fulton et al. 2003). The research was designed to identify whether a 1-day experiential workshop is an effective means of motivating agri-business managers to learn about other elements of the value chain, then act upon their newly acquired knowledge by purposely applying VCM principles to how they managed their business(es).

Delivered to agri-business managers across Canada between December 2007 and February 2009, the workshops were structured to reflect the adult learning theory first proposed by Kolb (1994), and the principles of VCM first proposed by Collins and Dunne (2002). The three areas of knowledge that the workshop sought to convey to the participants reflected that which the literature says individuals need to possess to become a member of a closely-aligned value chain. They are:

- The *conceptual* knowledge as to *why* the partnership is being formed (Batt 2002; Duffy 2005);
- the *operational* knowledge as to *how* to operate as a closely-aligned value chain (Boehlje and Lins 2008; Hornibrook and Fearne 2005; Whipple 2007); and
- the knowledge required for them to *consciously recognize* themselves as *part of a larger system* (Boehlje et al. 1999; Fulton et al. 2003; Johnson 2007).

Based on theory presented by, amongst others, Kolb (1984), Zull (2002), Moon (2004) and Jarvis (2004), the experiential learning process commenced with a concrete experience, provided in the form of video case studies. The facilitator than led the participants through a process of reflective observation, abstract conceptualism and active experimentation.

The decision to use video case studies as the concrete experience came from researchers [including Gross Davis (1993), de Bono (1999) and Zull (2002)] saying that video is a valuable medium for providing a concrete experience upon which individuals are motivated to reflect, then conceive how they might benefit from applying the knowledge to their own situation. This comes from how video appeals to multiple senses, while accurately depicting circumstances and issues to which the audience can readily relate, through being able to convey a large volume of information and differing perspectives in a short period of time.

As a value chain invariably involves multiple stages spread across a wide geographic area, it was expected that video would be an effective means of accurately conveying the structure, systems and players that together comprise the value chains being studied and discussed by the participants. It was also expected to be an effective means of enabling those already involved in closely-aligned value chains to accurately convey how they had benefited from belonging to the chain, along with how the benefits had been achieved.

An added benefit of using video is that it enables the end results to be conveyed to the participants, as well as how those results were achieved. De Bono (1999) states that showing the desired end results early on in the learning process is an effective means of providing participants with a clear sense of purpose about what the workshops are seeking to help them achieve. Knowing where they are heading and why lessens the likelihood that the learning experience will be negatively impacted by the participants feeling anxious, overwhelmed or out of control (Jarvis 2004; Zull 2002).

The videos were followed by a period of facilitated interaction. The participants were encouraged to share with their peers the extent to which the scenario they witnessed differed from their own situation and how they might act upon the information to improve their future opportunities. The facilitator then led the participants through a process of abstract conceptualism and active experimentation. This took the form of candid discussion among the participants, along with value chain mapping and role playing exercises. The hope was that this process would result in the participants being able to develop problem solving skills that they could later apply in their own situation.

The anticipated outcome of the workshops was for the participants to leave with a greater sense of understanding about the opportunities that they could realise through connecting with other individuals and businesses in new and innovative ways (Kolb 1984; Moon 2004; Zull 2002). It was hoped that this, along with a sense of achievement and a desire to emulate the successes they had witnessed in the videos, would stimulate participants to continue learning after the event. This, in turn, says Argyris (1995), Jarvis (2004) and Knowles et al. (2005) could result in individuals possessing the ability to develop ever more sophisticated problem solving skills.

4.1 Data Collection

Learning and behavioural change is a time-orientated process that is impacted by factors both internal and external to the participant (Kolb 1994; Knowles et al. 2005; Zull 2002). Researchers [including Easterby-Smith et al. (1996), and Pawson and Tilley (2007)] say that a combination of qualitative and quantitative techniques can provide a wealth of valuable data on the causes and extent of change in individuals' attitudes and behaviour; including the extent to which political or cultural factors influenced individuals' decision-making processes. Yin (2002) and Pawson and Tilley (2007) say that using multiple sources of data enables researchers to more clearly define causes and effects than would otherwise be possible.

For these reasons, data was gathered from four sources, using a combination of Likert scores and open ended questions. The first source of data came from using exit surveys, designed to gather participants' perspectives immediately after the workshop. The exit survey asked respondents to assess the workshop's structure, the usefulness of the material presented and whether they believed that it constituted a valuable learning experience. As researchers including Argyris (1995), Jarvis (2004) and Zull (2002) say that changes in an individual's perspective towards the surrounding environment and others is a precursor to double loop learning, the exit survey also sought to identify if changes had occurred in individuals' perceptions and, if so, towards what or whom. A final question asked their permission to follow up 12 months later to identify whether they had used information acquired from the workshop.

Easterby-Smith et al. (1996) and Robson (2002) are among those who say that semi-structured surveys are a valuable research technique. They enable researchers to delve deeper into specific areas of interest that may arise during the data collection process, while simultaneously ensuring that responses can be directly compared through analysis. Pawson and Tilley (2007) and Yin (2002) also say that semi-structure surveys provide an effective means of exploring issues relating to emotion and personal values, while simultaneously ensuring that the research remains focused on the issues being researched. They were therefore chosen as the primary technique for gathering data 12 months after the workshops occurred, with Likert scores used discriminately to help weigh individuals' depth of feeling towards specific criteria.

A third source of data came from a series of semi-structured interviews conducted with workshop organizers and hosts. The primary purpose of this element of the research was to help determine whether aspects of the workshop provided greater value to certain members of the audience, and why. The process also offered an opportunity to explore whether the organizers had communicated with anyone who attended the workshop since the event had occurred, and the nature of those communications.

The fourth source of data came from the workshop facilitator and researcher, being the same person. This provided intimate knowledge into the chain of events that occurred from designing the workshop through to analysing and reporting the results.

4.2 Results and Discussion

Of the workshop attendees, 279 voluntarily completed exit surveys. Of these, 108 stated that they were willing to participate in follow-up interviews. After non-responses, the number of follow-up interviews totaled 95. The average period between the workshop and the follow-up interviews was 14 months. Each interview lasted 20–90 min. Eighty percent of the respondents were managers of commercial businesses and the primary interest of the research. At a similar period of time after each workshop, the individual most connected with organizing each of the workshops was also interviewed. These responses totaled 14. Table 1 lists all the respondents.

Responses from the exit surveys and the follow-up interviews were coded according to whether the responses reflected evidence of factors that, according to adult learning theory, influence the effectiveness of experiential learning, in particular, evidence of double loop learning. This included factors such as whether changes occurred in respondents' perspectives towards their business, other elements of the value chain or the wider environment. Responses were also coded according to whether they reflected evidence of factors that, according to management theory, are important to effective VCM. These included changes in how they communicated with other business, which could lead to respondents perceiving the opportunity and possessing the ability to capture value in new and innovative ways.

The following is a selection of the research results. They show the extent to which changes occurred in the perspectives of the respondents who participated in both the exit surveys and follow-up interviews. The initial responses are presented to show any differences from results gathered across the overall population (n = 95). These responses are compared to those from respondents who manage commercial businesses, and those from respondents who manage commercial businesses and were later identified as having changed their management behaviour.

Table 1 Surveys and interview statistics

Activity		Number of participants
Exit surveys		279
Follow-up respondents		95
Follow-up respondents by sector[a]	Farm managers	41
	Processors	10
	Retailers	7
	Government	13
	Industry organizations	6
	Sales/marketing	12
	Other	6
	Commercial business managers[b]	76
Workshop organizers/hosts		14

[a]Some of the follow-up respondents were classified under more than one sector
[b]Total number of respondents involved in managing commercial businesses

Table 2 Exit survey responses

Impacts	All respondents by type (n = 95)[a]		MCB (n = 76)[a]		MCB who changed behaviour (n = 61)[a]	
	Number	%	Number	%	Number	%
Changed perspective about value chains	77	81	60	79	50	82
Perceived importance of communicating with other levels of the value chain	71	75	55	72	47	77
Changed perspective towards their business (or industry)	69	72	54	71	46	75
Changed perspective about factors critical to managing value chains	57	60	47	62	39	64
Identified way to use VCM to improve business or self (personal development)	51	53	42	55	37	60
Recognized specific factors involved in developing close business relationships	55	58	43	56	35	57
Learning from others' experience helped clarify how might implement VCM	43	45	32	42	30	49
Increased understanding of what VCM means as a business strategy	41	43	31	41	25	41

[a]Questions contained in the exit surveys were completed voluntarily. The number of responses received for any question does not, therefore, equal the population of any entire group

To illustrate the extent to which double loop learning may have occurred during the workshop and the potential reasons why, Table 2 illustrates the extent to which responses from the voluntarily completed exit surveys differ across the three groups of respondents. Table 3 illustrates the extent to which responses from the follow-up interviews differ across the same three groups. Out of the 76 Managers of Commercial Businesses (MCB) who attended the VCM workshops and participated in the entire research (exit surveys and follow-up interviews), 61 had changed their management behaviour during the intervening 14 months. Only 4 of the 61 expressly said that changes in behaviour were not directly attributable to the workshop; though their responses suggest that the workshop still played a factor in changing their attitude and behaviour.

5 Initial Impact

Results from the exit surveys show that the workshops led to at least short-term changes in respondents' perceptions towards their business and the world around them. In particular, the topic of value chains, VCM, and how or why they could benefit from adopting VCM practices. The majority of respondents stated that the workshops changed their perspectives compared to prior to attending the workshop and provided a sense of why they might consider changing their behaviour (both of which the literature says are important to facilitating double loop learning).

Table 3 Follow-up interview responses

Impacts	All respondents by type (n = 95) Number	%	MCB (n = 76) Number	%	MCB who changed behaviour (n = 61) Number	%
Benefited from learning how others have benefited from applying VCM approaches	89	94	72	95	61	100
Changed perspective towards their business (or industry)	86	90	68	89	61	100
Perspective included seeing my business (or client (as part of an inter-linked chain	86	90	68	89	61	100
Saw the importance of connecting operationally with other links in the chain	88	92	70	92	59	97
VCM offer opportunities that my business (or industry) are not currently exploiting	84	88	65	85	58	95
Identified how I (or my clients) could benefit by connecting with other links in the value chain	81	85	65	85	58	95
Provided knowledge that I could use to improve my (or clients) business	72	76	60	79	57	93
Saw the importance of communicating with other links in the chain	79	83	63	83	56	92
Consider it a valuable learning experience for improving management capabilities	76	80	61	80	55	90
Gave me ideas/knowledge that I reflected on afterwards	72	76	59	77	53	87
Viewing a business or chain as a series of processes and need for synergy	71	75	56	74	51	83

This suggests that the workshops may have been effective in establishing a base from which people were prepared to reflect on the appropriateness of previous assumptions in light of newly acquired knowledge, leading, potentially, to changes in attitude and behaviour.

The results do not show any statistically significant differences in how the perceptions of any of the individual groups changed in relation to a specific theme or item that was presented or discussed at the workshop. The primary differences across the three groups of respondents is in how a larger percentage of Managers of Commercial Businesses (MCB) that went onto change their management behaviour identified how they could benefit by adopting VCM approaches compared to MCBs overall and, in particular, the wider population. This suggests that those who went on to change their behaviour left the workshop feeling a sense of aspiration about emulating their peers. For those respondents in particular, the workshop appears to have been successful in establishing an emotional accord between them personally, the topic of VCM, and the value of the information for purposely achieving a desired outcome.

6 Reflection and Objective Reasoning

Results from the follow-up interviews show that the workshops were more successful in changing respondents' perceptions of their business or industry than suggested by the exit surveys. They also show that changes in perception occurred over the longer term, not only within the immediacy of the workshops, and that this led to objective reasoning, particularly among those MCBs that went on to change management behaviour.

Every MCB who changed his/her behaviour since attending the workshop had been influenced by seeing how others had benefitted from the application of VCM principles. This led them to perceive that they were part of a larger system and able to benefit by directly connecting and communicating with other links in the chain. The results show that these changes in perspective occurred most readily in MCBs that went on to change their management behaviour. This suggests that the workshop had led to them possessing a greater aspiration for 'why' and 'how' they might change compared to other participants.

The majority of respondents, particularly those that changed their businesses behaviour, also stated that the workshop provided ideas and knowledge that they reflected on after the workshop. This further supports the occurrence of double loop learning, through an emotional accord having been established between many of the respondents, the information presented, and the value they attributed to the acquired knowledge for helping improve their business opportunities.

An example of how this occurred in practice is reflected in a quote from a farm manager whose behaviour changed after attending the workshop. "When you showed that example, I saw it as a warranted way to do business. So I took it as an example that was worthy of showing people generally about new opportunities. That gave me the confidence to believe that I could do that too. Not that I had to copy this, though it was 'let's go ahead with this.'"

That this emotional accord may have led to changes in the mindsets, attitudes and behaviours of a wider proportion of those who attended the workshops, not just respondents who participated in the year-long research, is borne out by a statement made by one of the workshop organizers: "When I see some of them now that they attended the workshop, they may not be in a value chain, though they are still more open minded and more engaging. They are no longer only focused on themselves and have not reverted to their old ways of being more competitive. It has changed their perspectives and led to them being more engaging."

7 Enablers and Achievements

The extent to which changes in perspective, attitude and behaviour led to MCBs possessing the ability and motivation to capture value in new and innovative ways are illustrated in Table 4. Also detailed in the statistics and the descriptions listed

Table 4 Changes achieved

Changes	MCB who changed behaviour (n = 61) Number	%
New perspective led to changes in how I/we make business decisions	57	93
More focused on strengthening relationships with other levels of the chain	52	85
Purposely work with specific people/organizations	51	84
Communicate more with people at other levels of the chain	51	83
Greater belief in my own abilities, self-worth	50	82
More focused on reacting to market opportunities	49	80
Where to focus efforts, to increase chance of establishing/managing a successful chain	49	80
Provided knowledge and ideas that increased my confidence in applying and/or discussing VCM	46	75
Changed the information that I communicate to others	44	72
Crystallized my thinking on why I should change, led to making more informed decisions	44	72
Number of commercial businesses who have identified new opportunities	42	69
Engage more with other levels of chain in decision making process	39	64
Changed others' views towards me/my organization positively	26	42
Number of commercial businesses who have increased margins	20	33
Number of commercial businesses who have increased sales	17	28

below are enabling factors that led to them identifying opportunities and achieving the outcomes identified by the research.

The most commonly identified change in behaviour among the MCBs was in how changes in the perspectives they held towards their business and the environment in which they operated led to the majority of CBMs changing how they made business decisions. Many MCBs also engaged more with businesses operating at different levels of the value chain, overall and during the decision-making process.

Quotes from three respondents illustrate the extent to which their decision-making processes have changed, and why. They also illustrate how what the respondents learned from the workshops, combined with what they had learned from subsequent interactions with other members of the value chain (whether or not they had attended the workshop), led them to also possess a greater ability to act on their business decisions.

A farm manager stated: "We work closer with people and empathize more with the overall chain. By enabling us to identify how we might benefit from specific options, it also provided us with the ability to better assess the underlying reasons of why we should (or should not) be doing something." Interacting more directly with other levels of the value chain led him to realise that while his accelerated lambing system was bringing in greater revenue, his customers would prefer that he focused on supplying a specific quality of lamb during the naturally occurring season. While this reduced the overall price he received for his lamb, it allowed him to reduce his costs by a greater amount. This led to an immediate increase in operating profit. It also positioned him to be able to capture more information on the performance of his lambs, which he expects will allow him to identify ways to capture additional value over the long term.

An independent meat processor who operates his own retail outlet, while also supplying other retailers too, stated that what he learned at the workshop *"made me more aware of the middle man, how many steps are in my process and if they need to be there. Cut down my chain from 20 steps to three or four. Which has made the chain more efficient, provides more money ($) for the farmer and for me, and provides a better deal to the end customer. Keeping to three players provides more money and better value for all."*

The manager of a large meat processor stated how they had benefitted from viewing a case study of a closely-aligned lamb value chain with farmers, then discussing their differing perceptions of what they had witnessed and how they might move forward in a coordinated approach. *"Seeing how those guys were looking at the case study (allowed us) to identify people there who wanted to see if there are ways of working on a shared risk/shared reward basis."* The manager also stated that having insights into how not all farmers perceived challenges and opportunities in the same way had enabled them to *"have more meaningful conversations with those interested in forming a chain, which has helped change producers' minds and enabled us to move forward and embrace the management philosophy that already existed."*

These statements illustrate how some of those that attended the workshops had benefitted from what they learned. The statistics illustrate that the workshops led to the majority of CBMs adopting a more strategic approach to business than existed prior to them attending the workshop. This came from them possessing a greater array of knowledge towards the challenges and opportunities facing another element of the value chain, and perceiving themselves to be part of a larger system. This led to them developing the ability to communicate more effectively with other members of the value chain(s) in which they operate. The motivation to act on that knowledge came from the aspiration they felt from perceiving that they could benefit from working more intimately with others belonging to the same system.

While the findings show that the workshops did not lead to every CBM changing their perspectives or management behaviour, none of the findings refute the claim that experiential workshops are an effective means of motivating and enabling managers of agri-businesses to seek new ways of capturing value. The results show that those CBMs that did change behaviour subsequent to attending the VCM workshop are most likely to be those for whom the experience led to an emotional accord developing between what they learned from others (the how), the material presented (the concept), and that they could use the information to achieve a desired outcome (the why). This appears most likely to occur through the existence of a double loop learning process, which lasted long after they attended the initial workshop.

8 Conclusion

Experiential workshops that utilise adult learning theory to convey the principles of VCM are an effective means for changing the mindsets and attitudes of MCBs operating in the agri-food industry. In establishing an emotive bond between the individual, their situation and how they might utilize the information to achieve an identified opportunity, experiential workshops are also an effective means for motivating changes in the behaviour of MCBs. As stated by Argyris (1995), Knowles et al. (2005), Moon (2004) and Zull (2002), the results show that changes in behaviour are unlikely to occur unless individuals experience an event that leads them to critically assess their current values, ideas and beliefs in light of newly acquired knowledge.

The research expanded upon work by Kolb (1984), Argyris (1985), Jarvis (2004) and Ison and Russell (2000) to show that, in reflecting on what they have learned after the event occurred, a combination of aspiration for what they could achieve and confidence about how to achieve new and exciting opportunities creates within individuals a desire to act; in this case, purposely applying VCM approaches to how they manage their business. It also expanded upon work by Argyris (1995), Senge (1997) and Fell and Russell (2000), through showing that in interacting and communicating more effectively with other members of the value chain, many of the MCBs became self-directed learners. In perceiving themselves to be part of a functioning system, they are more likely to feel motivated to explore opportunities to work with like-minded peers to capture value in new and innovative ways.

The research was new and unique. It brought together various theories surrounding adult learning and the principles of VCM. With a degree of caution, the results show that experiential workshops are a good method for encouraging managers of commercial businesses situated along the entire value chain to adoption VCM practices. This comes from them possessing the motivation and ability to capture value in ways that they had previously not considered or thought possible. Following a similar approach in your own situation could prove the applicability and usefulness of experiential workshops for encouraging the wider adoption of VCM practices in different circumstances. It would also test whether the concept and expected outcomes can be generalized across different cultures and states of economic development.

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Measurement of Lean Value Chains: Efficiency and Effectiveness

Richard J. Schonberger

Abstract Key information relied upon in value-chain management (VCM) includes measures of "leanness" and cost. Regarding leanness, the clarity and utility of lean-efficiency indicators in value-chain action zones contrasts with the ambiguousness of lean-effectiveness metrics at higher VCM levels. Further confusion over measures of VCM performance are well known biases in conventional cost accounting and common misapplications of cost data. Through indiscriminate use of these kinds of muddled or dubious metrics, value-chain managers and executives may set inappropriate targets and plans leading to decisions detrimental to the competitiveness of the company and to its value-chain suppliers and customers. Alternatively, some executives may tacitly realize that the effectiveness indicators are confused and react by withholding strong commitment and support to the VCM effort.

Keywords Lean effectiveness • Lean efficiency • Performance management • Performance metrics • Value chain management

1 Introduction

In value-chain management (VCM) improving "leanness" emerges as a key objective, one that generally carries with it better quality and lower cost. Yet, global research indicates a dominant trend of worsening value-chain leanness (Womack 2007). A possible cause, addressed herein, is that senior value-chain managers and higher-level executives are presented with confused and inadequate performance measures, such that they lead to weak and unenthusiastic oversight of value-chain endeavors. Specific to VCM, much of the confusion may relate to the distinction between simple low-level measures of lean efficiency and complex high-level

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_4,

measures of lean effectiveness (a distinction delineated in a separate publication, in press). Other performance measures critical in VCM – for example, cost and quality – manifest their own points of confusion.

It is a truism that, for almost any improvement initiative, there must be executive-level support. In keeping with the truism, this paper posits that the problem of ambiguous VCM measures is likely to have the following impacts on the behaviors of senior value-chain managers:

- Some executives, tacitly realizing the VCM metrics are faulty, react by avoiding commitment.
- Sometimes, the avoidance of commitment to VCM takes the form of delegating responsibility to functional managers, which amounts to parceling off and thus obscuring the big picture of how VCM successes further company competitiveness. Functional managers, in their "silos," are likely to pursue parochial interests rather than optimums for the value chain.
- Another kind of executive, treating "the numbers" with undue respect, plunges forward in making decisions that are often harmful to VCM and by extension to the company and its suppliers and customers. Commonly, these executives do so month by month, perhaps as new monthly numbers appear on electronic scoreboards. As bad money drives out good, short-term expediency drives out long term vision. And as Dr. Deming explained, reacting to random, short-term ups and downs in an in-control process is "tampering."

In part, these propositions may contribute to a general theory of why admired process-improvement initiatives appear so often to lack staying power, fail early, or never achieve a meaningful presence. To the extent that this paper concerns theory development, it relies mostly on argument without much concrete proof. The portions of the paper bearing on common VCM tendencies and performance measures, on the other hand, are largely based on hard data plus published case studies and direct observation.

Main objects of the research are companies having complex, multi-stage value chains, which is characteristic of manufacturing, distribution/wholesaling, and retailing. These are inventory-intensive sectors in which materials – visible, countable, measurable, and an audited entry in companies' balance sheets – serve as an eminently researchable variable. In contrast, human and information services are problematic as targets of this research, given their lack of such common, concrete, on-the-books performance measures; and, moreover, their tendency toward comparatively simple value chains.

2 Methodology

The research taps the following information sources:

- An existing database of about 1,500 global companies, which provides inventory trends – and, by extension, lean trends – over a span of at least 15 years

(Schonberger 2008; Collins 2001, also uses 15 or more years' data in his research). These data apply only to publicly-traded, inventory-intensive companies – manufacturers, distributors and wholesalers, and retailers – for which audited financial records are available. The data point to issues in lean management of value chains, sub-dividable by region of the world and by business sector. Besides trends in total inventory, the database includes, for about one-third of the 1,500 companies, a breakdown of total inventory into purchased materials, work-in-process, and finished goods, corresponding to three primary echelons of the value chain. Such breakdown, again by global region and business sector, reveals whether main VCM weaknesses/ opportunities for improvement tend to be in supply channels, distribution channels, or within production operations.

- Phone and email interviews and secondary published information provide deeper information about a few of the database organizations. Companies undergoing these interviews and data searches are selected for standout features, such as exceptionally good or poor inventory trends. The aim is disclosure of underlying reasons for their good or poor VCM performance.
- Photos, graphs, and personal observation of performance indicators in use at various companies provide examples – ranging from beneficial to dubious – of low-level lean-efficiency and high-level lean-effectiveness measures, thus to further discussion on the complex role of goals and metrics in value-chain management.

3 Discussion

Lean efficiency – reducing waiting times and queues along the value chain – may involve actual timing, or just counting number of units in active and idle queues. Either way – timing or counting – lean results stem from process improvements in physical facilities, quality, demand management, and product mix, to name a few. These kinds of process improvements are likely to reduce costs as well as waiting times. Thus, inventory reduction serves as a simple and robust measure of lean efficiency in VCM.

Caution: Inventory reduction serves well as a surrogate for what is more customer-sensitive and therefore more competitively important: lead-time (cycle time, throughput time) reduction. (Time-based competition, in the form of just-in-time production and rising to strategic levels in the enterprise, has accumulated strong advocates: Stalk 1998; Stalk and Hout 1990; Blackburn 1991; to name a few.) Lead time and inventory are closely related according to Little's Law (Factory Physics 2010). Inventory data, though, are readily available – required by law to be in company's financial records; lead-time data are not required, nor are there standards as to how lead time should be measured.

Mid-level value-chain managers play key roles in monitoring VCM performance and reacting by organizing VCM improvement projects. Senior value-chain executives need to involved as overseers who step in when course correction is needed. Both mid-level and senior managers may benefits from visits to action zones in their own plants as well as plants and offices of suppliers and customers. These visits are opportunities to examine lean-efficiency metrics and plotted improvement trends as well as to demonstrate their commitment. In some companies such metrics, along with other evidences of process improvement, are elements of an in-place visual-management system. Visual management can serve as a simple and direct alternative to management by periodic, summary reports – which as is argued in this paper often suffer from ambiguities and biases.

Management by walking around (MBWA) – expanded in some cases to driving and flying around to visit far-flung facilities – is a well known term for these kinds of to-the-scene visitation (Peters and Waterman 1982, p. 122, 246). Given the demands of their own offices, however, value-chain managers have the time for *only limited amounts of MBWA. Thus (except in smaller organizations), their* responsibilities for steering the organization rely traditionally on summary effectiveness information – prominently, with regard to VCM, lean-effectiveness representations of lean efficiency.

Fortunately, lean efficiency's inventory numbers aggregate easily upward through the hierarchy, taking the form of inventory-turnover, a composite of time in queue, and value of units in queue. (Inventory turnover is simple division: The numerator from the income statement is the value of cost of goods sold in a given time period; the denominator from the balance sheet is average value of inventory in that time period.) Unfortunately, although this metric may appear to be excellent for monitoring and oversight purposes, inventory trends are affected by much more than lean/VCM activities. Despite best practices in VCM, companies' inventories may trend upward or downward because of mergers, acquisitions, and divestitures; shifts in the product line; the state of the economy; monetary exchange rates, and so forth. Value-chain leaders need to be aware of the false signals, from these and other influences, that arise when aggregating lean-efficiency numbers into higher-level lean-effectiveness metrics.

A related, narrower VCM issue has to do with who owns in-channel inventories, the supplier or the customer company. At hypothetical XYZ Inc., value-chain managers in purchasing, being measured on inventory turnover (or days of inventory) for purchased materials, can and do game the numbers. With the backing of company financial executives, they use clout or guile to ensure that what the supplier produces for XYZ stays on the supplier's balance sheet rather than on XYZ's. They and financial managers may spend more effort on this slight-of-hand than on solving underlying problems that are the causes of large purchased inventories and long lead times. Of course, if the supplier has the clout or cunning, it will ensure that what it produces for XYZ shifts quickly from its balance sheet and onto that of XYZ. These stratagems do nothing to reduce the costs, problems, and lead times in the supply channel. They are an artifact of accounting rules and conventions that need to be over-ridden jointly by the parties involved.

This is by no means the only way that accounting blurs the true cost picture. Because of the way overhead is allocated, the conventional accounting system is systematically biased, assigning too much overhead cost to standard, easy-to-produce, higher volume products and too little to hard-to-make items (Cooper and Kaplan 1986). That is the issue that gave rise to activity-based costing in the 1980s (Cooper 1988), expanding to lean accounting in the 1990s and 2000s (Maskell and Baggaley 2006). If value-chain managers are using standard costs as the basis for evaluating process options or making investment decisions, they are sure, frequently, to be making costly mistakes of omission or commission.

Cognitive dissonance, the quest of individuals to seek consistency among their cognitions-beliefs, opinions, and so on (Festinger 1957) may apply here: Executives believe they are obliged to drive the firm via high-level strategies, but are likely to be troubled by the difficulty in linking those strategies with low-level improvement activities. Among their coping mechanisms, a current favorite is to direct the organization to disaggregate strategies, level by level down the hierarchy, to bring about a comforting degree of consistency. A popular name for this is policy deployment or strategy deployment (Koenigsaeker 2006).

Although deployment of company strategies, policies, and goals is an outwardly reasonable pursuit, it seems problematic. Besides the complex make-up of strategies and policies, there are problems in the issuing and management of goals. As Deming put it (1982, p. 82), “Goals are necessary for you and for me, but numerical goals set for other people, without a road map to reach the goal, have effects opposite to the effects sought.”

An example (Hammer 2007): A fashion retailer’s high-level metrics (e.g., percentage of customers who buy something) were “desirable goals but not ones that can be achieved directly.” Advertising revenue seemed, to the chief operating officer, a better aimed metric. It wasn’t. The root causes were inadequate on-shelf availability and customer coverage. Those two less factors would become the new, less aggregated key metrics. The improvement of each would be “accomplished through process management.”

A second example (Morgan 2005): At EPIC Technologies, a contract electronics manufacturer based in Rochester Hills, Michigan, a lean manufacturing initiative was highly successful. For example, its lead time to Respironics, a key customer, fell from 2 weeks to 2 days or less. There were, however, setbacks. One followed management’s setting of an ambitious goal for inventory turnover. Overly tight kanban quantities in bins sized too small led to stoppages and late deliveries. One reason was that the work force was not yet sufficiently flexible. Another was insufficient equipment. Third, deliveries of electronic parts from the distributor were not quick enough. More problems arose in freight, which was not yet geared to handle frequent, small-lot deliveries.

My impression is that management by numeric goals was not all that common a few decades ago, but over time it has become ingrained, from the top of the hierarchy down to lowest organizational levels. At low levels, that seems proper or at least okay – if the goals are set by, and owned by, the teams doing the work and not by higher authority. At higher levels, problems of data aggregation becloud the numbers. At either low or high levels, numeric goals maybe replaced simply by trend lines: watching performance over time. Managing the process becomes ensuring that the trends are going in the right direction and at an appropriately steep angle. If so, the trend, prominently displayed as an element of visual management, provides team gratification and pride. If not (discounting randomness), the trend line scolds the team, triggering corrective action.

4 Findings

Hard data show, for most of the 2000s, that companies' inventory turnovers are worsening in nearly all regions of the world and industry sectors. Further, most of the worsening is in supply and demand channels and not in the factory echelon of the value chain. Since the latter typically gets the most attention, this finding tells us that VCM should shift a large portion of its process-improvement effort to the channels between companies.

The declining inventory performance globally is summarized in Fig. 1, a compilation of mean inventory turnovers in the past 15 years for a sample of 78 out of the approximately 1,500 companies in the database. It shows average inventory turns rising from 6.2 to 6.9 between 1999 and 2004, then falling sharply to 5.8 in 2009. A similar improving-then-worsening pattern applies in eight of nine global regions. The exception is Japan, which, after years of flat-to-worsening inventory turnover (roughly matching Japan's long period of economic malaise), has

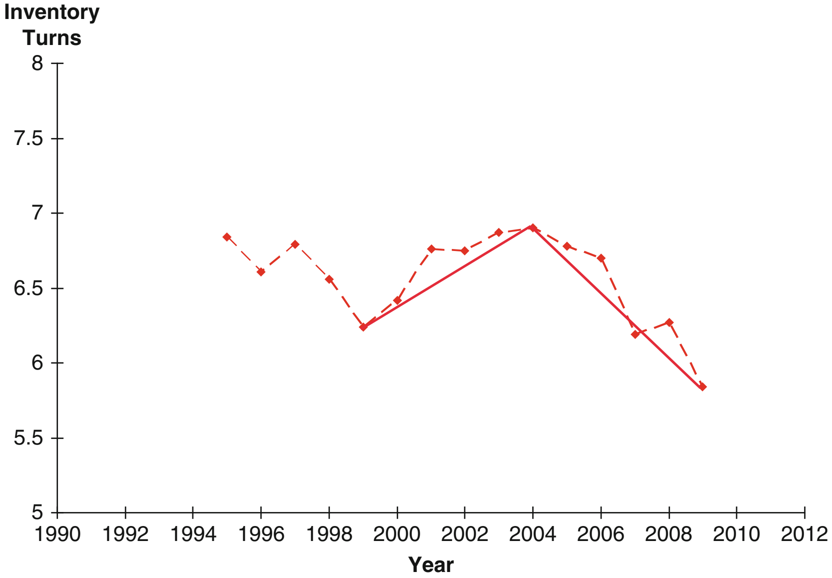

Fig. 1 Average inventory turnover for sample of 78 companies (Every 20th Company from 1,500 Company Database)

improved its turns over the past few years. [Using an objective method of scoring long-term trends, the research has shown that prior to its recent improvement, Japan – currently accounting for around 200 of the 1,500 database companies – had by far the worst score among the nine global regions (see Table 2 in Schonberger 2007)].

On a more detailed level, among industrial sectors studied only one – semiconductor manufacturing – is shown to have a dominant percentage of total inventory in the form of work-in-process (WIP). Other sectors studied have WIP inventory percentages ranging downward from around 35% (basic metal processing) to 29% (light motor vehicles) to less than 20% (heavy vehicles; electronics; electric; machinery/large appliances; liquids/gasses/grains/powders; food/beverage/tobacco; metalworking/machining; plastic/rubber/glass; and chemicals).

Sectors with high levels of purchased materials and supplier lead times include basic metal processing and pump/hydraulic/pressure, exceeding 40% of total inventory; vehicular components, about 35%; electronics and machinery/large appliances, about 30%. Sectors in which finished goods and distribution-channel lead times dominate include chemicals and light vehicles at about 70%; metalworking/machining and plastic/rubber/glass, around 67%; and liquids/gasses/grains/powders and electric, 60%. Near to or just below 50% in finished goods are heavy vehicles, food/beverage/tobacco, vehicular components, electronics, machinery/large appliances, and pump/hydraulic/pressure.

Overall, the dominance of finished goods puts the spotlight on the distribution channel: greatest opportunity for meaningful improvement in value-chain management. Progress toward that objective would logically center on reduction of inventories and lead times through intensive company-to-company collaboration to isolate and mitigate root causes.

4.1 Case Studies

Two case studies come to mind. One (Schonberger 2008, pp. 201–202) concerns Graco Inc., a manufacturer of spraying equipment in the pump/hydraulic/pressure sector. As noted earlier that sector has, as an average, nearly 50% of its total inventory in the form of finished goods. I am aware, also, that many companies in the sector sell through distributors, which carry a good deal more of the producers' inventories.

Graco had, by the mid-1990s, reorganized nearly all its main factory in Minneapolis into final assembly cells fed by quick-setup machining cells. Next major step was to shut down its many branch warehouses – no longer needed since its manufacturing cells had the capability to react quickly and flexibly: same-day shipments for orders received by noon. Graco shipments would now go directly to Graco's independent distributors. Before long, the distributors – the next echelon of the value chain – realized that they no longer needed to carry much Graco inventory. They greatly reduced that inventory, and began ordering frequently in small lots from Graco. Order patterns from the distributors and production patterns

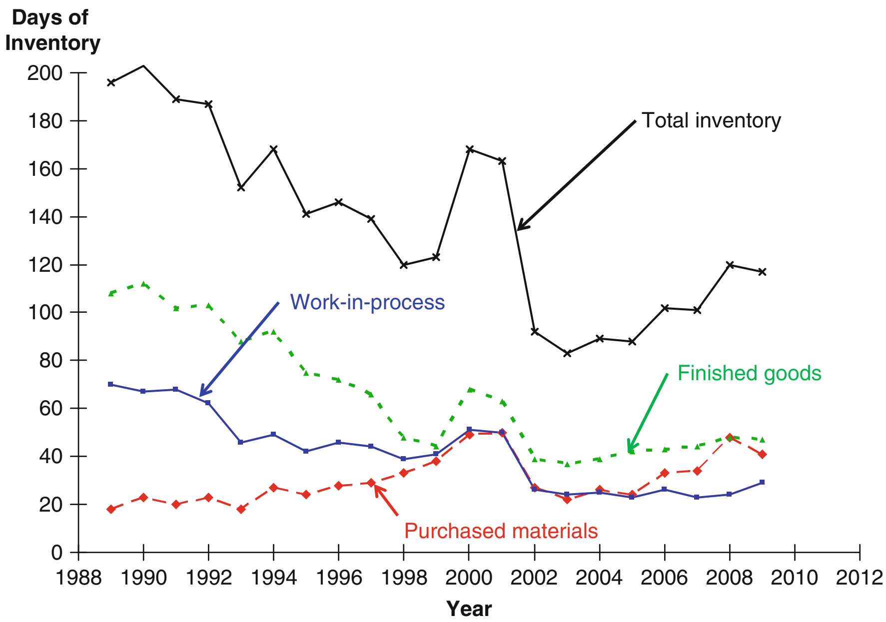

Fig. 2 Components of total inventory at Graco, Inc.

at Graco evened out, no longer volatile in size and frequency. Shipping, production scheduling, and purchasing, along with various administrative processes at Graco were simplified and routinized, with reductions in overhead and SG&A (sales, general, and administrative) costs. We see from Fig. 2 that these VCM improvements translated into sharp reductions in finished-goods inventory at Graco – from 110 production days' worth in 1990 to 40 days' in 2003. (After that, Graco made acquisitions of companies that lacked its lean manufacturing prowess and that therefore have had negative impacts on Graco's inventory situation.)

In retrospect, we see that Graco could not have achieved these down-the-value-chain benefits – which rippled back to reduce its own administrative and overhead costs – without first getting its own house in order through extensive application of lean manufacturing. In other words, the Graco case offers a valuable lesson in value-chain management, stated in two ways: (1) Lean inside the factory provides flexibly quick response, which facilitates and simplifies related value-chain improvements in downstream channels. (2) VCM in distribution channels benefits greatly when anchored by stability and predictability provided upstream via lean manufacturing.

How was Graco able to parlay its in-plant lean achievements into an extended VCM outcome that drove out multiple kinds of costs for Graco and its major customers? More specifically we may wonder if Graco executives were able to rise above by-the-numbers management, perhaps recognizing pitfalls in relying on highly aggregated performance measures in running the company. There is some small evidence of that kind of recognition. In personal visits and correspondence with Graco managers, I learned that Graco was averse to the usual stock-pumping practice of artificially generating end-of-year cash flow by drawing down inventories. Another sign: The executive in charge of manufacturing had the habit not just of management-by-walking-around but to spending a few hours each week running machines, assembling product, and otherwise interacting with the work force and their processes. That way the executive could stay highly informed and in a better position to make wise judgments about VCM and other issues, as compared with the typical by-the-faulty-numbers executive.

The second example, a Harvard case study (Hammond 1994), is about a frustrating but ultimately successful VCM effort by Italian pasta manufacturer, Barilla. The Barilla quest was to get its main in-country distributors to quit ordering irregularly and usually in large quantities, which caused Barilla to maintain costly, excessive capacity and jerky production and shipping schedules. It took about 5 years to convince the distributors simply to use their orders from retailers as purchase orders to Barilla: Since total retail demand was nearly flat, so should the distributors' orders to Barilla be flat. Barilla's persistence with the distributors exemplifies a best practice in VCM, but one that is unusual: Most companies just accept the orders passed down from customers, erratic though they may be, without seeking out and adamantly pursuing mutually advantageous alternatives.

Both the Graco executives and those at Barilla appear to have maintained a long-term whole-enterprise outlook, opposite to the tendency described early in this paper of executives whose style is to back away from VCM responsibilities or to react to monthly numbers posted on "balanced" scorecards.

Although the balanced scorecard is widely held to be beneficial, it also has its critics. As Bassett (2007) puts it, "There are no successful scorecards that tie into value programs, because the time horizons tend to be daily, weekly, or monthly, and value is the present value of future cash flows, hence a structural conflict . . . . [All] that useless data is itself an impediment to value-creating behavior, because it tends to make people try to game the system. . . . This is not to say measurement isn't important; it's vital, but scorecards are only a small part of the answer in operations and worse than useful in decisions about strategy."

These findings point to following conclusions: The ambiguities of the lean-effectiveness measures that senior managers generally rely on (aggregated inventory numbers and defective cost data) are likely to yield unconfident decision-makers. Lacking clear indicators, they tend to react erratically in the short term to small reported up and down numbers. This unsatisfactory climate for decision-making is troubling to the managers involved, which dampens their interest in and diverts appropriate attention from VCM initiatives. Lack of good support from on high, in turn, may be part of the reason for chronically worsening trends in value-chain inventory.

5 Summary and Corrective Action

The purpose of this paper is to introduce and explain a plausible theory pertaining to adverse tendencies in value-chain management (VCM) and the possible complicity of senior VCM managers. This paper posits that VCM suffers from ambiguous measures of VCM effectiveness, which may lead to weak senior-management support. More specifically, some of that confusion and inadequacy relates to the distinction between simple low-level measures of lean efficiency and complex high-level measures of lean effectiveness, to biased cost data, and to misuses of cost data.

This paper is much less about resolution of the VCM issues that have been addressed, and more about opening them up to scrutiny. A hope is that VCM managers and senior executives will come to better understand the hazards of managing "by the numbers," given the ambiguities and inaccuracies of aggregated numerical data, and act accordingly. High on the list of valued activity is ensuring avid and frequent collaboration with provider and user entities. These collaborations should include such measures as attacking root causes of high channel inventories rather than attempting to push inventories on the other parties' books. A few examples of relevant root-cause activity include:

- Determine critical costs through lean/activity-based accounting rather than relying on dubious data from conventional cost accounting;
- Rely less on highly aggregated performance data, including inventory turnover, and more on occasional interactions with low-level VCM activities and successes; in other words, staying knowledgeable about VCM by seeing its activities, successes, and failures first hand.
- Showing support and commitment to VCM less through setting goals and monitoring performance against those goals, and more by appearing at team presentations of VCM successes and participating in recognition and celebration of them.

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Part II

Best Paper

Product Returns and Customer Value: A Footware Industry Case

Ivan Russo and Silvio Cardinali

Abstract Managing the flow of product returns is increasingly recognized as a strategically important activity that spans different functions within and across firms, especially in terms of marketing and operations. We focus specifically on managing returns in the shoes industry. In order to explore the phenomenon of returns management, a qualitative research methodology was chosen to generate an in-depth analysis given the currently limited understanding of the present research topic. Our results suggest that returns management is recognized an increased role in inter-functional alignment and that this phenomenon is linked to different elements of the relationship value.

Keywords Customer value • Footwear industry • Functional integration • Managing returns

1 Introduction

Over the last 40 years, the international footwear market has experienced substantial changes relative to demand, supply and distribution (Moore and Fairhurst 2003; Buxey 2005; Camuffo et al. 2008; Gregori et al. 2009; Hsu and Chang 2008).

In the footwear industry, we see a vast array of products and more and more frequent outsourcing of production activities by many firms in order to achieve their competitive efficiency, which however generate more perils for the quality of

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_5,

products. It should also be noted that the intangible components of the products, such as image and post-sale service, become competitiveness elements among different firms. One of the complexity elements that we have found, and that is becoming increasingly more relevant, is the management of returns, that is, the whole of material flows connected to financial and information flows that for any reason travel back along the supply chain. The interest in this sector and phenomenon also stems from the observation of a few current trends: sales predictions that are increasingly more difficult to make, given the variability and unpredictability of the market; a difficult integration between marketing and logistics/production; the unavoidable need of the firms carrying recognized and prestigious brands to control the flow of returns, and the need to guarantee a high value-added post-sale service (Gecker and Vigoroso 2006; Verweij et al. 2008; Wehlage 2009).

From a practical perspective, Jayaraman and Luo (2007) noted that overall customer returns are estimated at 15% of sales for mass merchandisers and up to 35% for catalogue and e-commerce retailers in the United States. Furthermore, the Reverse Logistics Executive Council (RLEC 2010) estimates that RL costs account for approximately one-half of one percent of total GDP.

Blackburn et al. (2004) pointed out that the marginal value of time can be used to help managers design the right reverse supply chain. Thus managers recognized the perishability of returns and their loss of value over time and they had to extract value from the returns flow rather than simply disposing of product.

In view of this transformation in the distribution and supply area, we have observed therefore an increased complexity in market management issues (sales predictions, orders management) which make the relationship between the marketing, sales, logistics and production functions more critical. Managing the flow of product returns is increasingly recognized as a strategically important activity that spans different functions within and across firms, especially in terms of marketing and operations.

We specifically focus on managing commercial returns in the footwear industry.

Returns management includes several activities characterized by an inter-functional logic. These activities are *return avoidance* (activities aiming at minimizing upstream the number of *returns*) and *gate-keeping* (activities for the control of returns flow) as well as *reverse logistics* (*collection*, *transport*, *receipt*, *sorting*) and, last, the activities to redirect and allocate returns. There are many types of returns, Rogers et al. (2002) grouped in five categories: consumer returns, marketing (commercial) returns, asset returns, product recalls and environmental returns. We focus our paper on commercial/marketing returns, for example unsold products or job-outs or product quality reasons that retailers return to manufacturer. Briefly commercial returns are all those returns where a buyer has a contractual option to return products to the seller (Rogers et al. 2002; Flapper et al. 2005; De Brito and Dekker 2004).

By its own nature, a returned product involves several functions inside an organization: from customer service to sales/marketing, production, from logistics to management control/administration (Rogers 2002; Mollenkopf et al. 2007a). Therefore it requires coordination between these areas to afford efficient and effective management. Thus, functional integration is now recognized as an important component of the customer value theory, which emphasizes the importance of being customer-focused and aligning resources and capabilities for superior value creation (Slater 1997; Vargo and Lusch 2008).

Analysing the role played by the returns management process within the customer value creation is certainly of some interest not just for the inter-functional aspect but also for the role it plays in relationship management strategies. We have seen that the various contributions on customer value hold that many factors may influence this parameter (Lapierre 2000; Walter et al. 2001; Graf and Maas 2008). We make no distinction between consumer-originated returns (e.g., defective product and/or buyer's remorse) or customer (retailer) originated returns (unsold product being returned from the retailer). Thus, we want to understand how a shoemaking manufacturer can manage commercial returns in order to improve customer value.

For this reason, for the purpose of this research, we have used the model proposed by Ulaga (2003), who examines in business-to-business contexts the main "value-generating" drivers. In our case, we have verified the drivers that create value in the management of commercial returns in the footwear industry.

Many are the causes that make returns management inefficient (and not effective), such as a lack of coordination among the various actors of the supply chain in terms of information, material and financial flows, a strategic management of the operations connected to this phenomenon, an integration between the various process functions, the management and the agreements of the marketing channel, and the promised service level regarding customer complaints. For this reason, the problem of managing returns should involve the whole firm, as well as the retailers and suppliers, without limiting the issue to the mere management of logistics operations when the problem arises, and stressing even the most strategic aspects with a view to recovering efficiency, improving effectiveness and creating value (Roger et al. 2002; Mollenkopf et al. 2007a, 2011c).

Thus, the focus of our paper is to investigate the returns management process in the shoemaking context. In particular, our research questions are:

- What is the relationship between customer value and returns management?
- What are the main important drivers and steps that create value related to commercial returns management in B2B context?

Therefore, the gap in the literature we wish to fill specifically refers therefore to the management of returns in the footwear industry, paying special attention to value creation for customers in a business-to-business context, particularly analysing the manufacturer and retailer relationship. To this purpose we have used the model proposed by Ulaga (2003) as a framework for the identification of value-generating drivers in the management of returns.

In the following sections we will review the relevant literature and foundations of our research, describe our research site and methodology and discuss implications in managing returns for business functional integration in order to create superior customer value in a business-to-business context of the footwear industry.

2 Literature Review

2.1 Returns Management

The literature on returns management is rooted in both marketing and logistics disciplines, with an early focus, respectively, on reverse channels and reverse logistics, respectively.

In particular, the first contributions (Guiltinan and Nwokoye 1975; Ginter and Starling 1978) focused on the recycling of returned products, or parts or components thereof, and their environmental impact. Later on, in the 1980s, returns were connected to the concept of reverse logistics, primarily related to the idea of "going the wrong way" (Lambert and Stock 1982), therefore to a logistic flow opposite to the traditional one.

Several studies have focused on the green logistics (Gungor and Gupta 1999; Geyer and Jackson 2004; Murphy and Poist 2003). This research currently considers the management of returns as a way to minimize and control their environmental impact, from cradle to grave (Andel 1995; Barry et al. 1993; Witt 1993; Jahre 1995; Walther and Spengler 2005). Other authors (Stock 1998; Carter and Ellram 1998) have identified the drivers (legislators, customers, suppliers, enterprises) and the hindrances (mainly cultural and regarding the commitment of stakeholders and the upper management) to the development of reverse logistics programs. Other contributions have proven important (Thierry et al. 1995; Rogers and Tibben-Lembke 1999) to better investigate the strategic impact of reverse logistics in terms of competitiveness and cost reduction, inventory management, particularly in a remanufacturing context (Kleber et al. 2002; Kiesmuller and Scherer 2003), and concern for environmental and packaging problems (Kocabasoglu et al. 2007). Particularly noteworthy are further studies by Stock et al. (2002), which stress the existence of a strong correlation between good returns management and returns policies, not only as a cost but also as a tool to improve customer service (Petersen and Kumar 2009; Anderson et al. 2009; Russo 2008). Further research has been carried out by other scholars that are closer to quantitative rather than managerial approaches and focus their attention on the mathematical models that support reverse logistics; particularly interesting are the approaches regarding to the concept of closed-loop supply chain Dekker and Van Der Laan 2003). Blackburn et al. (2004) recommend the need to make disposition decisions as soon as possible in the returns process due to the time-sensitivity of most returned goods.

In the supply chain literature, Rogers et al. (2002) and Mollenkopf et al. (2007a) see the returns management process as a part of the overall supply chain strategy of a firm. Their focus on returns avoidance, gate-keeping, reverse logistics and disposal demonstrates the need to manage returns across multiple functional areas and within firms across the supply chain. Returns avoidance is a relevant part of the returns management process and includes the activities that prevent and eliminate the causes of returns (defective product and packaging design, compliance with legal requirements, poor demand management). While gate keeping involves the screening and authorization of products entering the return flow, disposition refers to inspection activities, the decisions to refurbish/remanufacture or resell or scrap the products that are returned from customers (Rogers et al. 2002). Stock, Speh, and Shear (2006) define avoidance as the "basic strategy" of managing returns (p. 58).

However, the majority of scholars tend to focus only one aspect only of this phenomenon, such as returns policies (Petersen and Kumar 2009), product recovery to reduce production costs (Guide and van Wassenhove 2006), reverse logistics (Stock and Mulki 2009) and the relationship between reverse logistics and green logistics (Jahre 1995; Geyer and Jackson 2004; Murphy and Poist 2003). Consequently, Rubio et al. 2008 call for more strategically focused research in order to develop a framework for future research.

Stock et al. (2009) have made various proposals showing how marketing, logistics, accounting and production need to be involved to manage returns. Following that research field, Mollenkopf et al. (2011c) found, using an in-depth case study, that functional integration at the marketing/operations interface in managing returns can lead to a better alignment of corporate resources and thus create higher levels of customer value.

2.2 Customer Value in Business-to-Business Contexts and the Role of Functional Integration

There are many definitions of customer value in a business-to-business context, intended as the customer's perception of the offer he/she receives. Customer value is primarily a trade-off between benefits and sacrifices – whether monetary or not. This trade-off is certainly influenced by what competitors offer and implies an assessment of what customers perceive in relation to what they receive (Jüttner et al. 2007). Surely, value creation is a central concept in the management and organization literature for both micro level (individual, group) and macro level (organization theory, strategic management) research (Lepack et al. 2007). As the name implies, customer value theory emphasizes the importance of being customer-focused and aligning resources and capabilities for superior value creation (Drucker 1973; Slater 1997), especially since firms find that product innovation and quality management alone no longer provide sufficient competitive advantage (Woodruff 1997). Suppliers often create account management teams that include marketing, operations, manufacturing and product design experts to more fully address the multiple dimensions of what customer organizations seek from their suppliers (Flint and Mentzer 2006; Ulaga 2003).

Customer value as a buyer behaviour has been researched for nearly 20 years. This work spans consumer (Smith and Colgate 2007; Gronroos 2008) and business (e.g., Ulaga 2003; Blocker and Flint 2007; Eggert et al. 2009; Flint et al. 2002; Woodruff and Flint 2006) contexts, with key researchers at the core covering both

(Woodruff 1997). Much of this work is traditionally referred to as customer value theory and some builds on means-end theory (Gutman 1982). Customer value theory describes how customers view what they value from products, services, and suppliers. The key focus is always on how service is exchanged for service, and not “service” for “good.” Products provide a service through embedded knowledge and goal facilitation. According with Payne et al. (2008), in the specific context of the S-D logic on co-creation has focused on: co-creating the voice of the customer (Jaworski and Kohli 2006); satisfying expectations (Oliver 2006); a cost–function model for co-production (Etgar 2006); supply chain issues and value chain management (Flint and Mentzer 2006); cross-functional processes (Lambert and Garcia-Dastugue 2006); and marketing strategy effectiveness and operations efficiency (Kalaignanam and Varadarajan 2006).

Building on the service-dominant logic (Vargo and Lusch 2008), customer value concerns the co-creation of value between suppliers and customers. Extended to the concept of supply chain management, the emphasis on co-creation of value drives organizational attention towards those activities that add to customer value (such as re-design, thus reducing wasteful packaging, or increased product refurbishment), and moves the attention away from the activities that do not contribute to superior customer value, thus making firms more efficient. Value can only be created where there exists a deep understanding of customers/markets and of matching supply chain capabilities. The ability to create value often rests on the need for cross-functional and inter-firm integration and collaboration to ensure that effective generation, dissemination, interpretation and application of knowledge co-creates customer value through superior integration of both demand and supply management processes (Esper et al. 2010).

The notion of functional integration and its associated benefits has been addressed by the marketing, logistics and operations literature for many years (Kahn and Mentzer 1998; Ellinger 2000, Kim et al. 2003; Piercy 2006; Menon et al. 1996; Kahn 2009). Much of the early literature on functional integration focused on factors that hinder or enhance functional integration, such as conflict or cooperation between departments, the role of top management and the impact of the traditional silo mentality within firms and the resulting lack of interaction between functional areas (Gupta et al. 1986; Ruekert 1987).

Yalabik, Petruzzi, and Chhajed (2005) identify different components of an integrated returns-management system: the refund policy, the marketing promotion strategy, and the logistics process of physically recovering and handling the returned goods. More recently, Mollenkopf et al. (2007b) addressed the importance of functional integration for Internet retailers’ marketing and operations in consumer service recovery situations. Still more recently, the demand/supply integration framework (Esper et al. 2010) emphasizes the need for extensive integration of the demand processes of marketing/sales activities and the supply processes of operations, in order to most successfully manage a supply chain that creates customer value.

3 Methodology

This research is of an explorative kind, just like other case studies of the literature (Gummesson 1991; Eisenhardt and Graebner 2007; Graebner and Eisenhardt 2004; Ellram et al. 2008; Daly et al. 2009). In business-to-business research, study profiles are continuously evolving, with new practices. Therefore the multiple case study seemed to us a good study method to analyze a phenomenon that has never been never investigated in the footwear industry (Yin 2003; Meredith 1998; Borghini et al. 2010; Piekkari et al. 2010).

In order to analyze the phenomenon of returns management, a qualitative research methodology was chosen to generate depth of understanding, given the limited current understanding of the research topic under consideration (Flint et al. 2002; Strauss and Corbin 1998). The main reason was the unexplored nature of this phenomenon in the footwear industry and the poor knowledge of the operational context inside the company.

We conducted interviews with 16 senior managers from different functions of five firms in the shoes industry in order to cover production, financial, marketing and customer service areas. The cases selection process wants to achieve the target to cover the typical business models in Italian footwear industry (SDA Bocconi report 2007): Classic (so called "partner" business model), Elegant (so called "brand integrated" business model), Casual and Smart (so called "niche" business models), Experience (so called "generalist" business model). Briefly we would like to show how different business models should create customer value through managing returns in business to business context.

To ensure rigor and solidify our knowledge in this specific industry, we also thoroughly interviewed a senior consultant, with a considerable experience in the different firms and the specific industry.

The involvement of several firms allows analysis of returns management methods in the same competitive sector although with different distribution, production, logistics and commercial practices.

It should also be noted that returns management becomes particularly relevant when examining the role played by this process within the commercial area (sales management) and for customer value creation. In this sense, it is helpful, in the variety of the real cases, to examine the role that "returns management" may play as an immaterial component of the products (service) and in particular as a value-generation process for trade clients (Ulaga 2003; Corsaro and Snehota 2010).

This fact-finding purpose called for a qualitative research method (grounded theory approach, Dubois and Gadde 2002; Strauss and Corbin 1998) which aims at discovering models and good practices rather than verifying theories.

The research questions were specifically phrased to provide an answer to "what" happened in specific situations, being as it is an exploratory research. However, this is not enough, as investigating into why and how certain phenomena occur is also necessary. Therefore, this research is in part also explanatory. In this way, we avoid the emergence of preconceptions that might induce interviewees to back the researcher's theory.

The study of the enterprises was as follows: on desk, involving the gathering of secondary sources (questionnaire data, Internet sites, other) to profile the enterprises before the interviews; bracketing interviews, whereby each researcher has preliminarily presented his/her expectations from the interviews and research, in order to avoid the emergence of preconceptions that might induce interviewees to back the researcher's theory; in depth interviews, site visits to each firm and printed materials by the firm.

Interviews were held individually with participating managers, with each interview lasting 60–150 min. An interview protocol guide with the main topics of research was used to follow up the grand tour technique. These topics were taken from previous research works on returns management and customer value (Carter and Ellram 1998; Rogers et al. 2002; Mollenkopf et al. 2007a; Flint and Mentzer 2006; Ulaga 2003). During the research, new topics emerged from the interviews. The debriefing sessions reflect our attempt to solidify our perceptions and thoughts with respect to what we were hearing. All interviews were conducted in Italian.

4 Results and Discussion

The model proposed by Ulaga (2003) proved helpful to conduct the exploratory analysis of the contribution given by managing returns in the footwear industry. Ulaga examined the main "value-generating" drivers in business-to-business contexts. In fact, this theoretical model has been developed in this context, in which the buyer enterprise is a manufacturing enterprise. In the case at hand, most buyer enterprises are distribution companies. However, the relationships between buyers and sellers are in most cases long-standing and characterized by a high interaction level (for example, the development of collections). Further elements of a certain importance are the characteristics of the sector, with such specific features that make only a few of the drivers proposed by Ulaga (2003) relevant. Finally, returns management involves the relationship value generation process only for a few dimensions (Mollenkopf et al. 2011c).

Hence, it seems possible in our analysis not to consider the "delivery", "time to market" and "direct product cost" drivers. On the contrary, based on the empirical analysis, returns seemingly take on a particular relevance in this specific industry as for several value drivers, i.e., product quality, services support, personal interaction, supplier's know-how and process cost. The following discussion is organized according to Ulaga's framework in order to respond to our two key research questions.

4.1 Returns and Product Quality

With specific reference to production activities in the strictest sense, it is evident that the returns process may contribute to improving product quality (Gronroos 2008).

However, in most examined enterprises, there seems to be a limited processing of the data that originated from the returns, such as for example the causes that have led a given (single or multi-brand) point of sale to recall a product or a customer to report it as defective. It is indispensable to adopt a common standard among the various geographic areas to guarantee visibility to all actors along the supply chain, as well as a homogeneous classification of returns. Control and visibility of the process should be a value-added element for a product with a prestigious competitive positioning, for which it is necessary to control the distribution as well as the returns channel. Instead, *"I've got it all handwritten, but I have no idea of how many pairs return or how many I manage to replace, repair and therefore reship to the customers. That I don't know,"* as one of the manager reported to us. In effect, we observed that in Elegance, Experience and Smart much care was taken of the returns from customers, to protect the brand and enhance the relationship with the retailers. However, in practice we seldom found the company functions aligned in the pursuit of the common goal of making returns management one of the value-creating elements.

Furthermore, product quality and usability are different issues than a mere quality control at the production level and evidently call for an integration of information and objectives among the company functions. Marketing policies for the launch of new products should also be based on information on the causes of returns and related complaints during the campaigns of previous years. At least in four out of five enterprises we observed therefore a lack of an effective *returns avoidance* process. Only in *Classic* we found a real effort to learn from returned shoes for quality problems, implementing a structured attention to the selection of raw materials suppliers, from hides and vamps to leather.

It is a common occurrence in the footwear industry that much attention is paid to the design and beauty, with little importance attached to the comfort and "user's experience" of the shoes. Returns are a good sign of the existence of a wearability or usability problem, as a manager told to us: *"More attention should also be paid to the comfort and use of the products, because shoes are certainly very beautiful, boots are very beautiful but when they are worn those problems may arise that maybe one didn't think of before."*

It is clear that the best preventive activity is to lower the overall quality cost born by the enterprises and better value should be transmitted to the customers. Only by gathering information and understanding the reasons for post-sale returns can correctly lead to product improvement in the following seasons. However, only *customer service* managers have understood the added value embedded in the returns and know how to learn from them in view of an overall product quality improvement.

4.2 Returns and Service Support

As for the *service* driver, we found that being able to rely on a quick replacement of defective products or, better yet, having an efficient after-sales support are all customer-service and, consequently, marketing strategies that, without a successful returns management process, would be useless and ineffective. These efforts are certainly bound to produce a positive effect in terms of value transmission also on the image of the manufacturer/distributor, acting as a further differentiation element, which we observed in several instances. As such, one of the Classic's firm managers, referring to a domestic market, reported to us: *"Three days pass from the moment we receive it from the customer to the moment we ship it back.*"

In addition to that, it should be said that customers in these instances may be in a somehow critical situation and be more "sensitive" because they observe unequal "quality expectation" and perceived/real quality, which in turn might reflect on the overall evaluation of the customer/supplier relationship. Or, in case of a product being returned not for an evident quality problem, there might be problems of a commercial nature related to the point of sale (low sell-out, low merchandise turnover, too many promotional sales with respect to regular price sales). It should be noted that return process could generated a break in customer relationship so, in some cases, firms offer a customized support service, as the Casual's Sales Manager observed: *"I have seen that there should be only one person liaising with customers, because if too many people interfere on a particular issue, then it becomes hard to manage. Therefore I give my name with the authorization number."*

The above instance is a strategic choice given the high competitive positioning – in terms of price and reputation – of at least four enterprises of the sample and the types of customers they interact with, who are very demanding especially in some foreign markets. This choice however should also produce, among the various company functions, a common aspiration to pursue customer satisfaction, which however does not occur in the returns process because there is a lack of perception of the real impact on the enterprise – in terms of costs – of the commercial returns and the potential dissatisfaction of retail customers.

A further element connected to (*pre-sales*) *service* is the communication of *returns policies* and observance of related regulations. As for our entire sample, especially Elegant, Casual and Smart, this informative activity is carried out in a non-structured way. In fact, it is neither formalized nor shared by the upper and operational management. On the contrary, we have found the opinions of the various interviewees contradictory, and an inconsistency between informal *returns policies* – in many cases, expressions like "yes, in theory it is like that, but at times. . .." – and operational practice. In this scenario, also in view of the economic impact of returns, informing and educating retail customers on the costs connected to the returns and the related return process becomes critical. In this sense, it is important to remind of the importance of observing strict procedures and establishing a collaborative and not *problem-creator* approach.

4.3 Returns and Personal Interaction

We have also observed that in this specific industry returns take on a particularly relevant role as regards the buyer/seller interaction process (personal interaction). In fact, returns management rightly belongs to the elements for the negotiation of orders ("it is a negotiation we conduct this way"). Furthermore, even from a time perspective, we observed that some commercial returns in a given season become problematic during the negotiation phases of the following season.

Regarding the activity of gate-keeping, the authorization to accept the returns is given by the sales department only. In this case, the preferred choice is always to accommodate the customer's request and to instruct the administration and finance departments to pay back the customer. In this situation, abuses on the part of customers are not infrequent. In fact, during not particularly happy seasons, customers may transform unsold items in defective items, exploiting to their advantage the intrinsic characteristics of shoes (*"each hide differs from another," "it is therefore easy to reject a pair of shoes for any reason"*) and customer service policies ("customers are always right"). Hence, gate-keeping activities are rather weak, generating, for marketing reasons, additional costs to the company general operations.

In this scenario, a critical role is played by the internal sales staff or by the agents. To this regard, we should stress the importance of the discretion of the sales staff who evaluates the methods to accept or reject the commercial returns from the retailer: *"It is therefore easy to reject a pair of shoes for any reason*."

Sales procedures (in many cases only informal and occasional) largely differ from one another and oftentimes managing returns and liaising with the customers is the responsibility of several people (sales manager, customer service, marketing).

We also found that the returns process is handled by the staff with a personal approach. In many instances, the returns management method is the result of a subjective choice, which varies based on the person adopting it as well as on the customer/market that has generated the returns. It is as though each function or area perceives, manages and organizes returns autonomously with respect to the functional objectives, thus creating within an enterprise closed silos that do not ease the flow of information from one department to another, in order to draw a benefit in terms of effectiveness and efficiency. Moreover, in other instances, the sales staff may act with a variable level of autonomy which is formally recognized only in part: "our boss . . . is aware of this occurrence (replacement of unsold items) but he would prefer this not to be done."

4.4 Returns and Supplier Know-How

The supplier know-how driver by Ulaga's model (2003) constitutes a fundamental component of the set of elements that make up the value of business clients at the same times supplier "know-how" is another element to create customer value with returns management process. The relevance of this aspect has also been confirmed in the case of the examined enterprises. However, it takes on a different perspective because the technological or in any case technical/productive component is not fundamental. Instead, the selection of materials – in terms of reliability and innovation – and suppliers (in some instances located abroad) is important. This results in less problems of qualitative non-compliance of products. In some observed enterprises – for example, the Classic enterprise – a critical role in creating customer value is played by the ability to meet the design features required by the buyers with technical solutions, within a fixed timeframe and at pre-fixed prices (target pricing).

It should also be said that another relevant element for returns avoidance is the ability to follow fashion trends as well as recommend to the customers the best choices to support sell-out, in terms of lines, models, colours, materials and sizes. Therefore the knowledge provided to retail customers on main fashion trends and real market opportunities constitutes a critical element to transfer knowledge to the customers also in view of preventing commercial returns. However it should not be overlooked that a driver for value creation comes from market knowledge. This aspect becomes particularly relevant for small clients such as multi-brand points of sale or small chains. The Sales Manager of the Elegant company, speaking of a client, remarked: *"you haven't sold it because you made it of a colour that has been made only by you, that is, I mean …*"

Based on the investigation, it emerges that *Supplier know-how* for the footwear enterprises implies knowledge of the supply chain and production capability as well as market knowledge and design and commercial sensitivity. Supply and customer market knowledge can help the seller to provide appropriate levels of inventory in the marketplace and support the value creation of the customer (Mollenkopf et al. 2011c).

4.5 Returns and Process Cost

The value of the product changes significantly and the appropriate reverse supply chain structure is a combination of responsiveness and cost efficiency to keep the value of the commercial returns (Blackburn et al. 2004).

Returns generate several different costs which do not merely consist of the value of returned products and they are often considered a necessary cost-of-doing business. In fact, this "direct cost" should be coupled with all indirect costs connected to returned products, i.e., reverse logistics, inspection, remanufacturing, shipment to outlets, and finally, disposal. Furthermore the removal of a product from the exhibition space may jeopardize the sales results of that particular product. In this sense it is appropriate to consider the role of returned products as a "reverse-sales" element. This aspect may be particularly important, considering the strong seasonal character of these products and the quick loss in value of highly fashionable shoes. However in the various enterprises there is no systematic activity that encompasses in an organic system all the costs (activities and persons) that are connected to the returned products.

Even though the cost of commercial returns is not clearly quantified, the examined enterprises find the administrative and logistics management rather problematic and try to avoid it also adopting specific actions and choices aiming at reducing the material flow of returns. The Classic company for example gives its major customers (mostly store chains and large distributors) a discount of approx. 1–2% off list prices. By doing this, the company eliminates any returns flow and related complaints, thus also containing the cost born by the customer. The entrepreneur remarks: *"We have implemented a returns system whereby we give a discount to the customer in the invoice of 1% to avoid the return of single pairs of shoes."*

A further and rather interesting aspect in reducing the cost of returning products is the gate-keeping procedure. It is in fact important not to accept "shoes in indecent conditions" which do not have a direct value and create process costs. To this regard, a few selected enterprises have defined procedures to remotely assess quality problems. When a real problem is found, in some instances the manufacturing company may issue a credit note or discount for the following orders.

A different situation was found with regards to enterprises that manage single-brand points of sale. While unsold items in multi-brand stores are not a problem for the manufacturing enterprises, in the case of direct points of sale the manufacturing enterprises are also exposed to risks in terms of control of the channel and protection of the brand. In general, for this kind of returns, the manufacturer adopts policies towards single-brand points of sale that allow them to order any product quantity, guaranteeing in return the collection of returned items at no additional cost. However also for unsold items, just like for returns due to quality problems or products to be replaced, in a *cost management* perspective, we should consider the loss of sale of displayed shoes that have no market, picking, packing and temporary storage at the point of sale, freight cost, cost of returns authorization procedures and subsequent payment of credit and, finally, the activities to decide the following destination of the merchandise which is usually shipped to the outlets.

Overall, despite the imprecise assessment of the actual cost of returns for the customers, footwear enterprises take specific actions in order to contain this cost.

5 Key Findings, Managerial Implications, Limitations and Future Research

In this section we will review the main key findings and managerial implications of our results. We will then describe limitations and future research.

The first element that has emerged from our investigation is certainly that the functions involved consider returns a multidimensional aspect with different customer value impact/perception that generates much complexity to manage the process. In fact, we have found a rather variegated classification of commercial returns, which may be due to quality problems, non-compliance with orders, late shipment and delivery, unsold items from customers, and unsold items from direct or single-brand points of sale that are not always easy to identify. Moreover only customer service managers understand how the returns management process should be drive by the "commercial perishability" of the product. This classification – often scarcely structured – is coupled with the nature and resulting value of returns, which can be items to be disposed of, repaired or sold at a discounted price (second-choice or last season products).

The second element to be noted is the importance of returns management in the relationship between supplier and customer. In fact, it is part of the elements embedded in the customer service of the shoe-making enterprises and therefore an element that creates value between buyer and seller. At the same time, commercial returns are a relevant part of the relationship with the customer. In fact, "the voice of the customer" (Woodruff 1997) may be heard during this process and it constitutes a substantial part of the value creation and transmission process between supplier and customer. However we have mentioned several times that this objective is not shared by all enterprise functions, which results in the shoemaking enterprises not putting into practice effective policies of returns avoidance, improved product quality and containment of reverse logistics.

The third element to be considered is the operational and strategic role of the products returned. So the main operational problem in managing returns in the footwear industry are the so-called "defective or low-quality products" or "product replacement" excluding end-of-season unsold merchandise (*marketing/commercial returns*), which however account for a considerable percentage of the marketed products.

Despite this, managing returns is often considered – as in the case of *Elegant*, *Casual* and *Smart* – exclusively a post-sale competence, disregarding the fact that the causes of returns may also lie in other functions. This is one of the reasons that should most induce the managers to consider returns management and avoidance a transversal process of the enterprise that can actually create value for the customers, through improved product quality and service, and similarly contain the number of returned products to be recovered by the enterprise.

To sum up, we examined the main "value-generating" drivers in business-to-business contexts and we observed that different aspects of returns management involve the customer value process; however the drivers analysed have a variable role in shoemaking firms. For the drivers of *product quality*, *service support* and *personal interaction*, the majority of the firms recognise their importance for the returns process, but only in a few situations do the firms define specific managerial tools to improve or manage them in a better way. On the other hand for *supplier know-how* and *process cost* drivers many firms seem to not perceive their relevance. On this point of view a lot of managerial improvement could be brought about these firms starting with highlighting the important of the return process across the function or increasing the competence of sales people.

In addition, on a strategic level – despite the peculiarity of this industry – returns are a symptom of a lack of coordination among the various functions and reveal the need to manage distribution as well as return flows. Seasonal overstocks, unbalanced sell-in and sell-out levels at points of sale, weak gate-keeping activities are a few elements that reveal the inability of the enterprise to create value, effectively managing returns. This situation is often generated by a lack of coordination among the various company functions which results in end-of-season returns, particularly considerable for the *Elegance* and *Smart* enterprises. Let us take for example the cost to return, inspect and assess the merchandise, indirect administration costs (issue of bills, invoices, packing lists, credit notes, etc.) and time-related issues (shipment/return may take weeks).

However, we hope that our study may help future research to confirm in other contexts the evidence we gathered. Furthermore it is clear that the drivers considered for the analysis of the value of returns management are based on a model taken from the literature. It is however unclear the impact that these may have on each other and this is certainly an aspect to be investigated in future research.

Future research in this specific industry should certainly investigate more in-depth the retailers in order to describe the methods by which customers perceive the value transmitted through returns management. Furthermore an issue that we have analysed only in part is the analysis of the value attributed to after-sales and returned products in contexts that are different from a geographical and competitive standpoint.

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Part III

Searching for Value: Creating Value

Chairs:

Gary Gaukler
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Ivan Russo
David Walters

Cooperative Engagement to Define and Deliver Client Value in the Construction Industry

Tomas Nord

Abstract Relations in the construction industry are traditionally of arms-length, and client value is realized by contractual arrangements. Partnering, as a concept of strategic and project alliances, has been suggested to change the adversarial behaviour by moving towards a more cooperative climate. In the consumer market there are recent examples of changes from firm-centric view of value creation to a co-creation view, with intimate interaction between consumer communities and producers to jointly define and deliver value. The case study has an explorative purpose of describing a cooperative contracting engagement of a local Swedish contractor, when engaging in a recent project. The result shows the opportunities of applying the building blocks of improved interactions to reach co-creation of value: dialogue, access, risk-benefit and transparency. The early and interactive involvement of the contractor with the developer and end-user established project objectives valued and favoured by all parties before the procurement. Important capabilities of the contractor included project management, cooperative behaviour and design and calculation, and a strive to have a pleasant and friendly realisation of the project.

Keywords Capability • Co-creation • Construction industry • Partnering • Value

1 Introduction

During the past decade the technological development has opened up for increased interaction of actors in the value process. Customers are actively engaging in the process resulting in a changed view of the market as a place for value exchange.

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, DOI 10.1007/978-3-7908-2747-7_6, © Springer-Verlag Berlin Heidelberg 2012

The traditional way of viewing the consumer goods market has been the distinct roles of producers and consumers. The market was the place for exchange with little consumer activity in the value creation process (Normann and Ramírez 1994). Instead, the value creation process took place within the firm (Porter 1980) and the relation with customers was that of targeting and managing the right segments and customer groups. The traditional view of value creation was that of self-interest value determination, with little relation or cooperation with the market. Prahalad and Ramaswamy (2004a, b) indicate a change in the consumer goods market. Informed, connected, empowered and active consumers are increasing the consumer-to-consumer communication and increasingly choosing the firms that they want to have a relationship with based on their views of value creation. Online auctions are an example of this where the customer pays according to their value definition of the goods and not based on the cost structure set by the firm (Prahalad and Ramaswamy 2004a). Consumers are increasingly taking an active part in the value creation process.

In the capital goods market interaction with customers is more of cooperative nature in the value creation process. Customers do often have a definition of the value they are aiming for and are then choosing producers accordingly. The interaction between actors is then defined in contracts and producers are commissioned through a tendering process. A specific case of capital goods market is the complex products and systems (CoPS) (Hobday 1998). CoPS consists of a large number of sub-systems produced by a number of different actors and developed together with the end-customer and are exemplified by flight simulators, telecommunication exchanges, aircraft engines etc. (Hobday 1998) and intelligent buildings and residential housing (Nord et al. 2011). In the latter example, the construction industry, the value creation process follows a number of fairly well defined phases from an idea by a client to design and procurement of working actors followed by the actual production phase before the building is handed over to the client for further sales and usage by end-users. Each phase in the process involves interaction between different actors with different resources and capabilities. The value creation process of construction is therefore often of temporary nature and to maximise each individual actors' own process rather than the overall project.

The construction process is itself a hindrance for collaborative engagements. Clients are procuring contractors based on price and competition rather than trust and cooperation. This often results in claims of additional work outside the commissioned work. The process has thus gone from cooperative win–win approach to a claim-seeking stance (Rooke et al. 2004). To obtain a cooperative atmosphere between actors, clients should opt for soft evaluation parameters for contracts such as competences, earlier experiences, collaborative ability or other incentives for collaboration (Cox and Thompson 1997).

Research has shown that partnering is a possible way of overcoming the competitive climate created by the traditional procurement approach and to reach a more collaborative environment (Barlow et al. 1997; Eriksson et al. 2008), but concluded that although actors in the construction process are aware of the possibilities, there is little concrete done (Ibid.). It is argued that although clients are interested in changing the present procurement approach, which leads to a competitive atmosphere rather than collaborative or cooperative, they often feel vulnerable in their relations to contractors and thus apply the traditional detailed contractual arrangements (Kadefors 2004). This behaviour hinders cooperation and has a negative effect on innovation and development of the industry. In a collaborative project setting with cross-discipline cooperation the delivered value to clients ought to be higher as the actors have developed a climate of trust and responsibility.

The issue raised in this research is whether a co-creation process between the construction client and contractor (as a system integrator) of defining and delivering the overall project and customer value could be applied, and what capabilities of the contractor is of most importance to operate in such a process?

The next section discusses the perception of value and the peculiarities of the construction industry to set the stage from a theoretical perspective. The study has an explorative purpose resulting in a case study approach which is described in the subsequent section and followed by the description of the context and actors. The analysis contrasting the results with the theoretical findings precedes the concluding remarks and managerial implications.

2 Theoretical Framework

2.1 Perceptions of Value

The definition and measurement of value is difficult to most firms (Anderson and Narus 1998) as it requires a knowledge of perception of others. Miles (1961) presented four different types of value for an item: use, esteem, cost and exchange. Use value is defined as the qualities and properties that follow with a use, job or service. Esteem value on the other hand is what cause a want in an item be it the features, properties or attractiveness. Cost value is simply the total sum of costs needed to produce an item, and finally exchange value as the qualities and properties of something that enables it to be exchanged for something else (Miles 1961). From these four definitions Miles (1961) defined value as *the minimum amount that must be expended in purchasing or manufacturing a product to create the appropriate use and esteem factors*. The definition has a firm-centric perspective which is also found in literature of business markets. Anderson and Narus defined value as *the worth in monetary terms of the technical, economic, service and social benefits a customer company receives in exchange for the price it pays for a product offering* (Anderson and Narus 1998, p. 54). The definition centres on the exchange of a product from a producer with money from the customer, i.e. the market is the place for value exchange. The firm has created value through its activities inside the firm and its value chain (Porter 1980, 1985), whereas the customer is outside the firm and the value creation process. The producer and the consumer have distinct and different roles in the value creation process.

The market, with all its customers, is the target for a producer offering. The relationship between producers and customers, from a producer perspective, is to target and manage the right customers with the right offering in order to obtain optimal economic value extraction. To do this the firm must either analyse and determine the most profitable industries and market segments and build advantage from generic strategies (differentiation or cost leadership) by developing of acquiring necessary capabilities (Porter 1980, 1985) or build competitive advantage based on the resources and capabilities the firm already possesses, either internally or through co-operations (Barney 1991; Peteraf 1993). The aim is to improve the fit between the offerings and the demands of customers from the firm's business model (Porter 1991; Normann 2001; Hedman and Kalling 2003).

The technological development that has resulted in increased interaction between suppliers, producers and consumers on a global level has turned the focus on the value creation process and the role of customers. While customer interaction has always been important in new product development (von Hippel 1988), and thus the creation of value, the widespread deployment of the Internet has greatly enhanced the ability of firms to engage with customers in the value creation process. Today, in the consumer goods markets, there is increasingly use value that is becoming important and that the customer is determining the value. Normann and Ramírez (1994) argued that the value chain was made up of networks of actors including the customer and they were discussing value constellations. In the value constellation view, the customer is the co-producer of value thus interacting with the firm. The term "prosumer" was introduced in which producer and consumer together define and develop the product and service thus the co-creation of value (Normann 2000). Recent examples of co-creation are the on-line auctions where customers are able to define the value at a specific moment for a specific item without depending on the cost structure of that product from a producer perspective (Prahalad and Ramaswamy 2004b). Producers have to increasingly interact with customers in their value experience of the products and services in order to obtain the necessary value. Prahalad and Ramaswamy (2004a) argue that the interaction with consumers come anywhere in the value system and the building blocks of these interactions for co-creation are: dialogue, access, risk-benefit and transparency (DART) (Fig. 1).

Dialogue is the transfer of ideas, demands and possibilities through conversations between two parties. It often requires equal size and on the consumer market this has to be solved somehow.

Access and transparency is necessary for an open and constructive dialogue. Traditionally, firms have placed limits on how much access and the type of transparency the customer is allowed for. But to have a meaningful dialogue this has to change, and through consumer communities and other sources, an individual consumer can often get enough information for a rational co-creation interaction.

Risk-benefits is the result of the above three elements. From an open dialogue based on access and transparency to information, the consumer can make a clear assessment of the risk and benefits of the value exchange.

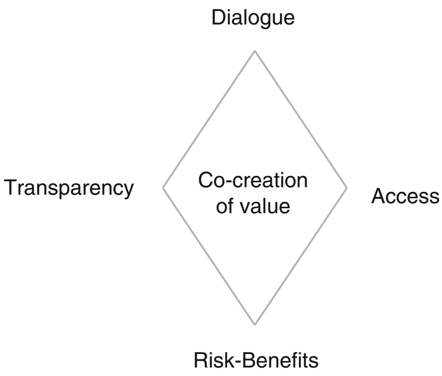

Fig. 1 Building blocks of interactions for co-creation of value (Source: Adapted from Prahalad and Ramaswamy 2004a)

By engaging the customer in the value creation process and focus on the experience, firms have to change from its present firm-centric view of value creation to a co-creation process in which the consumer takes a more active role in the value chain development. Firms are able to create virtual customer environments using the Internet and to create on-going dialogue with customer and thus tap into the knowledge of the consumer (Sawhney et al. 2003).

The construction industry has traditionally defined value by the term ‘cost’. A building envisioned by a client has been designed and cost calculated by technical consultants followed by a competitive tendering process often with the lowest bidder as winner. The winner has no or little guarantee of further future work. The winner may in turn commission a sub-contractor to realize the work to lever what they can out of the contract. The construction project and the building process are thus typical cases of transactional cost economics (Williamson 1988; Winch 1989). To solve governance and control, detailed contracts are used. The result has been an adversarial arms-length relation between a large number of actors with opportunistic behaviour rather than cooperative (Cox and Thompson 1997) and where the contract is the source of defining value.

The value in a contract is defined by the cost the client is willing to spend on the project and the margin for each contracted actor is thus already defined. The result is that price becomes the main parameter in the evaluation of tenders (Sou 2002; Eriksson 2008). The focus of contractors is then often on cutting costs of material and labour rather than a process or systems perspective.

2.2 *Overcoming the Peculiarities in Construction*

The short-term focus on relations is a result of the peculiarities in construction projects (one-of-a-kind production, site production, temporary work organisations) further enhanced by the competitive tendering and the usage of standard typified contracts for different work positions and various tasks (Briscoe et al. 2004;

Eriksson 2006). This has manifested the arms-length relation and opportunistic behaviour in the industry. A result is that the industry has been lagging behind in productivity development and also in innovativeness (Egan 1998; Sou 2002).

Different measures to overcoming this has been proposed, such as new contracting types, various alliances (partnering) and increased end-user/client–contractor involvement.

The sheer number of different work positions and tasks and the peculiarities has resulted in the development of standardised *contracts* of what is the minimum inclusion in a work task. These contracts are referred to when agreeing upon a project. There are also project specific contracts defining the design, production and assembly of the project. Until the mid-1980s a general contracting was the dominant type in Sweden where the project was designed and defined in detail by the client and a competitive tender process was allocated between many different contractors and specialists. As construction rates declined in Sweden in the beginning of the 1990s many client lost their competence in project management and started to use D&B (Design&Build). In a D&B contract a main contractor are responsible for interpreting the ideas of the client as well as producing the project with own or external resources. The result has been a concentrated market with three or four large contractor accounting for 70–80% of all large housing projects (SOU 2002). Another example with higher involvement of contractors in the design and development of the end-product is BOT (Build-Operate-Transfer) projects. In these contracts the contractor takes a larger responsibility and also risk and has emerged as a response to lower client competence in project management as well as shrinking margins in pure production (SOU 2002).

Increased collaboration and cooperation are by many seen as the antidote to the problems in industry (Egan 1998; Sou 2002; Cheung et al. 2003), and studies have shown the benefits (Larson 1995). In construction these *alliances* between parties are referred to as *partnering* and are either as project or strategic alliances. A project alliance typically is a short-term collaboration in a single project or based on a method between two or more partners. The objectives are clearly project or business related but there is a transfer of skills and resources in order to meet the objectives of the project. Strategic alliances are long-term cooperative relation between two or more parties aiming for achieving a competitive advantage. There is a clear objective of pooling skills and resources in order to build advantages and to reach common as well as specific goals (Love et al. 2002). There are studies showing the advantages in areas such as quality, safety performance, sustainability, dispute resolution, human resource management and also cost reductions (Barlow et al. 1997; Egan 1998; Chan et al. 2003). On the negative side are the difficulties to implement a long-term cooperation as it requires a “paradigm shift” (Larson 1995) in behaviour of many actors in the industry with little prior experience of collaboration. There are arguments that clients should take a stronger role in establishing a cooperative atmosphere for partnering to take place (Ng et al. 2002). The latter is of interest as partnering is mainly used between main contractor and sub-contractors to elevate the offering to clients. Lately, D&B contracting has been used to meet these needs but it is seldom that the client or even so the end-user is involved in the actual production and assembly of the project. They are not co-creating the final building.

In complex products and systems industries the usage of co-creation is more prominent as the products are complex and often requires concurrent product development and innovation (Hobday 1998). A system integrator has developed to solve the project management and the relations with end-user but also to ensure that manufacturers in different stages produce components and sub-systems that meet the overall design (Ibid.). In construction, Winch (1998) proposed two different system integrators: the main architect/engineer at the design phase and the main contractor at the construction phase. The main reason is the well-defined phases in the building process based on tasks requiring specialists and the behaviour to solve procurement and governance by using contracts. Discussing the role of the system integrator, Winch (1998) made this based on the traditional building process in which the property, construction and facilities management parts seldom are included. The role of the client is thus not fully integrated and it is therefore a barrier to developing a full life-cycle approach. A greater involvement of contractor in the specification stage (together with the client) could shorten the project duration and better meet client demands (Akintoye et al. 2000). By involving client and contractors as early as possible in the building process without relying on formal contracts, could result in a climate for collaborative ways of working and an improved possibility to meet project objectives on time and cost. It is not specified who should be the system integrator but it depends on market segment, national context, industry culture etc. In Sweden, the larger contractors/developers are often viewed as system integrators (Lutz and Gabrielsson 2002; Sou 2002).

3 Methodology

The empirical research concerns construction projects and the use of a particular contracting form as a mean to increase client value. As such the contracting form is little described in literature or in practice (Gullmander et al. 2010) which calls for an explorative study. Studying a phenomenon in its natural environment and in a real-life setting, a case study approach is often seen as appropriate (Yin 2003). A case can be described as a class of events or as a phenomenon of scientific interest, where a phenomenon might be the use of an innovative approach of actor relations. A case is then, “a well defined aspect of a historical episode that the investigator selects for analysis, rather than a historical event itself” (George and Bennett 2005, p.18). Also, with an aim of seeking the role of the contracting form in defining and creating client value rather than describing the approach itself, the explorative aim of the research further seconds the case study approach.

The research approach and process of further studies follows the suggestions of Eisenhardt (1989):

Formulation of the research problem: The objective of the research is to exemplify value in the building process and how a particular type of contracting and economic transfer model establish value to meet client goals.

Selection of case: The studied company is one of a few in the country using the contracting form and work process. The contracting type is a special case of the Design and Build contract and the work method Partnering. The studied company has conducted a project using the method in the nearby past.

Data collection: The data collection included interviews with top management of the contractor and complemented with documents regarding the specific project. The interviews were conducted at the office of the contractor and lasted for 1–2 h at a time. The structure of the interviews had a semi-structured format following some pre-set headings.

Data analysis: The data analysis was that of comparing the obtained data from the interviews with the theoretically found elements of capabilities

Research agenda: From the results of this study, further research could concentrate on how the diffusion of new contractual arrangements proceeds; how the relation between contractor and sub-contractor is arranged for future projects; and how the contractual type and network relations meet the conditions of public procurement legislation.

4 Results

The project and industry setting is an office building in a medium large city in Sweden with a regional developing company as client, the regional branch office of a national real estate company as end-user and a regional contractor that has moved towards cooperative contracting and environmentally friendly construction using timber structures. The following section presents the different actors in general terms and their cooperation in a recent project.

4.1 The End-User

The end-user is a regional branch office of a national real estate company. The company commissions and manage residential, office and commercial buildings in own name and supports housing cooperatives with legal and practical advice. The organisation is present in all regions in Sweden and has about 2,000 employees and some 360,000 tenants.

In 2007, the company formulated an environmental policy (Riksbyggen 2010) to be implemented by 2011. Among other things the energy consumption of the total residential stock should be lowered with 20% by 2020. This means on-going renovation projects as well as energy efficiency focus in the new build (30% lower energy consumption compared with old apartments). The same goes for office and commercial buildings. Other important areas are resource efficiency, improved transportation and focus on air and interior environment.

In 2008 the company initiated discussions with the contractor of building a new office building for the branch office, emphasising the environmental issues but still with high cost efficiency.

4.2 The Client/Developer

The client is a local real estate developer operating on the residential housing and commercial building markets. The company owns some 800 apartments and a number of commercial buildings for office and industry purposes. It is focused on buildings in central area in the cities of operation, and is involved in new build and renovation activities.

The company has worked with the contractor company previously and was therefore familiar with the work method of cooperative contracting.

The capabilities of the company are that of real estate management and project development, financing and a deep knowledge of the local building market.

4.3 The Contractor

The contractor is a medium sized company (about 35 employees) founded in 1998. The owners and management have long experience from the construction industry from other companies but wanted to work from an own position. The company has focused on the local and regional market and of new construction of commercial buildings as well as the renovation of older, culturally valued buildings. A specific niche is the timber frame housing in which the company has capabilities in design and production using CLT (cross laminated timber).

The company has developed a work method which they call cooperative contracting. It is based on a Design and Build (D&B) contracting with close and direct contact with client, sub-contractors and preferably end-users (Fig. 1). The method is based on trust between actors and a commitment to the overall project goal to deliver value to all participating actors. Some 10 years ago the company got involved in a project which had gone out of hand and the client, a public organisation, wanted to redo it and to involve all actors to a higher degree. The result was a success and triggered the company to continue developing the method. The company has since then established long-term relations with sub-contractors with capabilities not possessed by the contractor itself. This includes for example ventilation, electricity, water and sanitary and technical consultants. The relations are such that the companies operate together when possible, inform each other of possible projects but have no limitations working with others. The company has

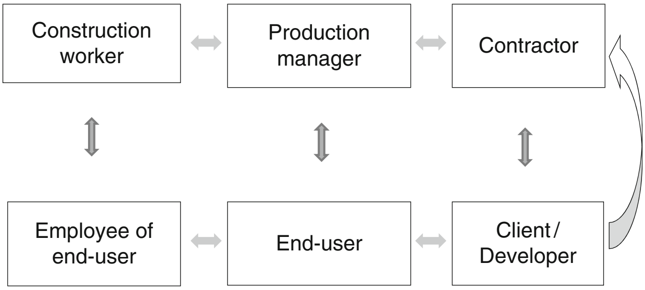

Fig. 2 Cooperative engagement between actors during the project realization

learnt the specific capabilities of the different sub-contractors and tries to engage the “right” one when possible.

The method is centred on initial meetings with the client to defining the specific and underlying project values (see Fig 3 for a project process example). In a normal case there are two to four initial meetings between client and contractor to interpret the specific needs of the client of this particular project and to establish a friendly and cooperative atmosphere for the remaining project. Technical consultants are involved early to give the framework of the project and for the later specification of technical issues to sub-contractors. The managing director states that this creates trust between the client and the other actors, and especially since the company (contractor) is able to present rough but often fairly accurate cost figures before the tendering process in a normal project. The cost figure comes from the fixed pricing of sub-contractors which often accounts for 70–80% of the total contracting costs. With a project proposal according to the clients plan and fixed pricing from sub-contractors, the tendering process and contracting play a subordinate role in the value creation. The managing director also stresses the need for openness on the economic side, i.e. the client and end-user should have direct access to all costs in the project to be able to make appropriate decisions. Also, the contractor has a 10% margin on the agreed total construction cost.

The company then acts as main contractor in a D&B contracting and develops the proposal into a detailed project plan. To monitor progress the contractor has developed a project reporting program, which can be accessed by all actors anytime to follow progress. Furthermore, there are bi-weekly meetings with all actors to present progress and discuss changes, problems and solutions (Fig. 3).

These meetings are attended by people involved in the project and with the authority to propose and implement changes. The aim is to maintain focus on client and project values and to meet the overall time plan and the economic frame of the project. Solutions to problems should meet the end-user’s demands in first hand and in second hand the efficiency of the individual work operations. The managing director states that too often he has seen solutions to problems that only benefit the continuation of that particular work and not the needs of the client. Unless you have the end-user involved directly (which perhaps is not possible in all projects) the client/developer has to attend that role and thus be competent enough of both end-user needs but also production possibilities and limitations.

The capabilities of the company are, according to the managing director:

- Project calculation skills, i.e. translating client needs and technical consultants frameworks into a manageable project with a well-defined cost structure
- Project management skills, i.e. the administration and coordination of actors during the project to meet the goals of the project.
- Cooperation skills. The ability to make companies and people work towards a similar goal while maintaining a good spirit.
- Independent carpenters. The skills of the company's carpenters are little different from others but they have learnt the management and cooperation skills of the company and are therefore better adapted to make own decisions.

4.4 The Project

In 2008 the contractor contacted the end-user with an option of developing a new office building for their regional branch office. The contact was made from the newly introduced environmental policy of the end-user stipulating that, along with cost reasons, all projects should be evaluated according to environmental issues for example CO_2 emission and energy efficiency. The contractor had designed and produced a number of timber framed buildings in the region and had developed a relation to a CLT producer and a capability in using the product. The initial building permit application was rejected and the project was delayed. The financial crisis started to affect willingness to build but in spring 2009 the contractor had found a new site and contacted a local developer whom they had cooperated previously. Together they again contacted the end-user and after initial meetings and the development of documents for a new application, the proposal was accepted.

The first meetings between the developer and the contractor aimed at defining the value to the developer and a possible client, the benefit to the contractor, and a rough sketch of what was possible on the site. Technical consultants were contacted to give advice on the general design and to set the technical framework of the initial plan. Based on this information the contractor calculated a rough total cost, which was presented and discussed with the developer. The end-user was invited to give further feed-back of their demands (that had changed slightly from the previous discussions). Small changes were made and the contractor could specify various work tasks and ask possible sub-contractors for an indicative cost. A new, more precise, cost structure was presented to the developer which the developer could base his rental demands on. The whole plan, cost structure and an estimated maximum rent was presented to the end-user, with the incentive that if they proposed any changes that would lower the project cost, the developer would lower the rent with the same margin. On the other hand, if the cost would increase the rent would not follow. The final proposal was a 1500 m^2 single-storey building with CLT framing, fibre insulated walls, district heating and individual heat and ventilation control in all rooms. Calculated project costs came to approx. 2.7 million Euros.

After they had agreed on the overall project specifications the legal documents were signed. Since the contractor already had had initial contacts and asked for appraisals from sub-contractors the tendering and procurement process was easily done. According to the managing director it is seldom that they change sub-contractor but it happens, and since they have a wide network of possible firms they are often able to choose the most appropriate one.

As the actual production started the project team continued with the bi-weekly meetings but with a different set of people. Technical consultants had minor roles at this stage and instead construction workers of various disciplines came. The role of the meetings was to monitor progress, discuss next steps and raise problems and find solutions. These meetings were often short and the main benefit was the role and involvement from the end-user. Any problem that was raised was solved to meet the needs of the end-user in the first place and the production/assembly in second (Fig. 3).

The finished building was controlled by the technical consultants (which had started to attend the meetings at the end of the project) before it was handed over to the developer on time. The end-user could move in as decided. Some minor things have had to be fixed afterwards but since the project team has had direct and intensive contacts throughout the project they were solved without any legal disputes.

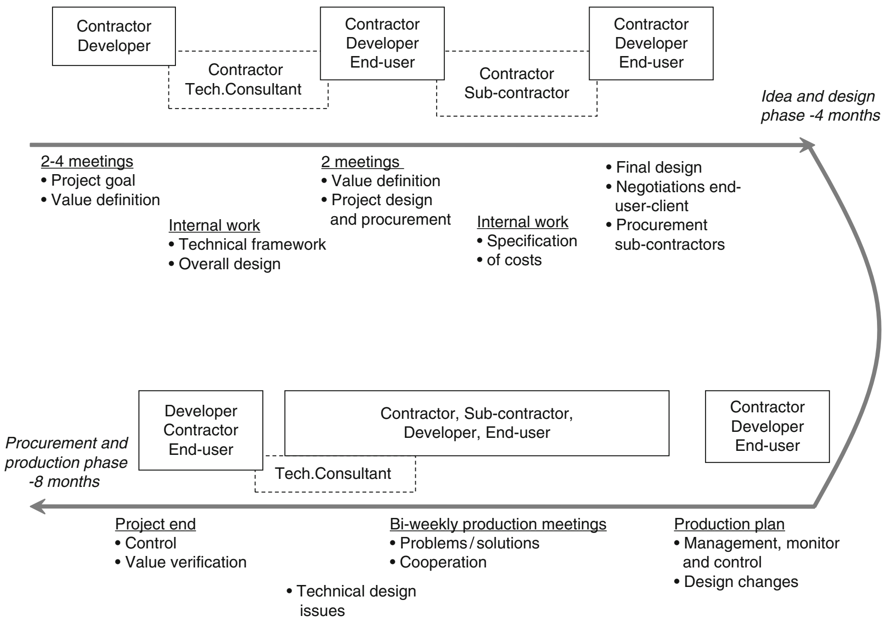

Fig. 3 Project realisation; actors and activities

In summary: The finished building had a square meter cost of 16200 SEK (approx. 1750 Euro) which was lower than first calculated despite additions of the end-user. The project time was approximately 12 months split into 4 months of design and procurement and 8 months of site production.

The developer and owner got a building which fitted in the overall stock, to a price which was lower than first proposed (total end-cost of 2.6 million Euro) and with a tenant that is pleased with the standard. The cooperative engagement lowered the normal costs for a developer as most of them were handled by the contractor and during discussions and meetings.

The end-user is renting a building in which the employees have had much to say about. The rent is lower and with a standard that is higher than first proposed.

The contractor has spread the cooperative contracting methods to yet another end-user, and at the same time deepened the cooperative relation with some of the sub-contractors.

5 Analysis

5.1 Value Definition as a Co-creation Experience

The contracting method used by the contractor with the client was analysed with the building blocks to interactions suggested by Prahalad and Ramaswamy (2004a). The building blocks are: Dialogue, Access, Risk-benefits and Transparency (DART) which could indicate whether there is a firm-centric or if there is a case of consumer-company interaction in value creation.

Dialogue: The contractor initiated a dialogue and invited not only the developer but also the end-user in the dialogue. The contractor made sure they all were on equal terms and defined the different responsibilities and area of authority. The aim was to start building a cooperative climate which could lead to trust. In the construction industry, cooperation has often been defined in contracts and through economic incentives but economic incentives may result in short-term focus and not create trust in a project (Kadefors 2004). By offering an "open-book" relation (transparency), with initial meetings on the cost side of the contractor if there is no project, the contractor offered both economic incentives as well as a willingness to trust building. Also in the production phase there was a continuous dialogue aiming at monitoring progress, raising problems and finding solutions meeting the end-user and project objectives. Maintaining a cooperative climate built on trust kept the project within cost limits and with few late changes or errors having to be fixed afterwards, which is also shown in partnering projects (Black et al. 2000; Holt et al. 2000).

Access: Except for the first meetings between developer and contractor, the end-user had full access to all information before and during the project. This is necessary for meaningful and trustworthy dialogue and is a move away from the asymmetric relation in a firm-centric relation (Prahalad and Ramaswamy 2004a).

By allowing access to project progress, cost structure and other project dependent factors developer, the contractor was able to shift risk and effort to customers and sub-contractors. These in turn benefitted from getting what they wanted with greater speed and higher accuracy (Thomke and Von Hippel 2002).

Risk-benefits: The developer stood the risk of having to pay for the technical consultants if there hadn't been any project, and the end-user would be without a new office as well as losing the time during the initial meetings of defining the objectives and specifications of the project. The benefits were larger especially for the end-user as they were involved throughout the project and had an economic incentive to find functional and cost-effective solutions since it would lower their rental cost. In a traditional D&B contracting the end-user, the main contractor has to interpret the needs and demands of the client in its proposal which then is interpreted by the client. As partnering is increasing in acceptance (Eriksson et al. 2008) this may change and projects that are today run with a partnering concept may be similar as to the method used in this research. This means that, by extending the initial idea and design phase of the building process and involving the end-user as well as contractor in a dialogue and with open access and transparency between actors, the actual D&B contract has less importance to the project objectives. It also lowers the costs of the developer as these are handled during the initial phase at meetings and mainly by the contractor.

Transparency: The project was transparent to all main actors from the very beginning which was crucial to establish a cooperative climate. The actors in a construction project operate with different business ideas and within different industry segments manifesting the cultural barriers which is prominent in the industry (Egan 1998; Sou 2002; Kadefors 2004). Overcoming these barriers transparency is important (Cheung et al. 2003) as in the case example with shared project monitoring and an open discussion climate at meetings. Even if the sub-contractors were operating on fixed pricing they were active in problem solving with the overall project objectives in focus. Many of these had already been working with the contractor and had thus knowledge of the cooperative engagement and the positive results of being open in discussions.

The interaction between the three parties in the design phase of the building process is close to the co-creation experience space suggested by Prahalad and Ramaswamy (2004a, b). The goals of each of the parties were the basis for setting the overall project objectives, and by engaging in dialogue with open access and transparency the risk-benefits were met by all actors. The success of co-creation in this particular project was the combination of initial open meetings and the open atmosphere in project meetings throughout the project.

5.2 Capabilities in a Cooperative Contract Engagement

The contractor acts with an "open-book" approach, i.e. gives access to the cost structure of the overall project and invites the other parties to a co-creation value process. This approach comes from the capabilities of the firm as a system integrator. The contractor has long experience in project design and management coupled with skills of collaborate with actors in the building process. The open-book approach, is perhaps the biggest difference to the normally competitive and sometimes adversarial behaviour in the industry (Egan 1998; Dubois and Gadde 2002; Sou 2002; Chan et al. 2003). A positive outcome is that the initiative comes from the contractor but with an aim of benefitting the end-user and client. There are indications that clients are aware of the need for increased cooperation but lack the stimuli to initiate a change (Akintoye et al. 2000; Eriksson et al. 2008). The contractor is acting from a customer and project perspective and not from a firm-centric view, and does this from a stand-point of self-knowledge. Perhaps this is what the construction industry needs, to meet the argument by Prahalad and Ramaswamy that managers must think from a customer and an experience perspective and not from a company perspective (2003, 2004a).

6 Conclusions

This explorative study has indicated a contracting and cooperation method that places the client and customer values in the forefront. The main contractor engages the client and end-user in a cooperative engagement with a tight-loose relation benefitting all parties. The method is a development and extension of the partnering concept (strategic and project alliances) but where the contractor as system integrator contracts, controls and combines sub-contractors and internal capabilities and also integrates the competences and needs of the end-user.

The work method used by the contractor has a clear objective of creating value for the client and also the end-user. The contractor has a long experience in construction projects and a network of sub-contractors that give them a sense of security when proposing a cooperative engagement and development of a project with a client. Their definition of value is a finished project and a possibility for repetitive assignments, and is obtained from their design and project management and cooperative capabilities. The method is based on design and project management and cooperative capabilities.

Similar developments have been seen in the consumer market as the IT development has progressed to merge consumer groups to consumer communities. For firms in the future this means they have to engage in co-creation experiences with customers and move from the product space via the solution space to the experience space (Prahalad and Ramaswamy 2003). Although there is a difference between consumer markets and the construction markets in terms of size and number of consumers, the construction industry should have large possibilities to move towards even larger customer interaction and co-creation of value. There is a willingness by clients to increase interaction and move towards larger collaboration, but they are hampered by the culture in the industry and especially the formal standardised contracts and rules (Eriksson 2008). What is required is a focus on certain capabilities and who will take the lead. This research has indicated that perhaps a contractor could be the lead actor in a change.

Future research would centre on how to market the cooperative engagement to a larger audience. The contractor is a small contractor operating on a local/regional market and has limited possibilities for extensive marketing. The new engagement is different from the traditional methods and thus challenges the culture in the industry with its strong path dependency. What is the role of public procurement legislation in a contracting behaviour as the studied? Are there possibilities to benefit from the recent environmental debate and over usage of resources by indicating the optimal use to client and end-user demands? As society is moving towards increased openness and sharing of experiences through social media, the used and proposed working method of cooperative contracting and engagement must have a bright future.

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An Investigation of ROCE and Its Drivers: Empirical Analysis of European Companies

Heimo Losbichler, Peter Hofer, Christoph Eisl, and Birgit Zauner

Abstract The quest for value and profitability has attracted substantial interest among researchers and managers over the last decades. Even though many studies have been conducted most companies struggle to provide competitive returns. The golden path of being profitable has not yet been unveiled. This article analyses the long-term profitability and its drivers based on a sample of 23,489 European manufacturing companies, from 2000 to 2008. The empirical study reveals that companies have not been able to increase revenues and the Return on Capital Employed (ROCE) simultaneously. However, statistically significant differences were found among industries, countries, and between small and large companies. Furthermore the paper presents the correlation between the drivers of profitability and the impact of value drivers on ROCE. The study illustrates that growth strategies, without managing cost and assets effectively cannot provide profitability.

Keywords C2C-Cycle • EVA • Profitability • Return on capital employed • Revenue growth • Shareholder value • Value driver

1 Introduction

Intense global competition has resulted in a significant focus on providing competitive returns to shareholders (e.g., Stewart 1991; Copeland et al. 1994; Lewis 1994; Günther 1997; Hostettler 1997; Ittner and Larcker 2001; Weber et al. 2004; Lueg and Schäffer 2010). While shareholder value goes by many names, virtually all

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_7,

concepts are rooted in the idea that the return on the capital required for doing business has to be higher than the interest rate a business has to pay for this capital to lenders and shareholders. In other words the Return on Capital Employed (ROCE) or the profitability of a company has to exceed its cost of capital.

A firm's profitability can be improved by three generic and basic value drivers: higher revenues, lower costs, and lower capital employed which in turn all can be disaggregated into more specific drivers. To increase profitability management has to identify those initiatives that provide a considerable leverage on profitability. Unfortunately, the majority of management activities have multiple consequences (many of them unintended) affecting more than one value driver (Fig. 1).

Over the last decades significant research effort has been made in different areas of this topic. However, the DNA of corporate profitability has not been unveiled yet. There is a lack of current empirical evidence regarding the leverage that value drivers actually provide and their linkage. Thus most companies are still in quest for value and remain uncertain about how and where to direct their initiatives to maximize ROCE.

This paper illustrates the long-term evolution of the Return on Capital Employed and its value drivers, the effectiveness of value drivers and the connection between the value drivers by means of secondary research, based on a sample of 23,489 European manufacturing companies, from 2000 to 2008 (data resulting from AMADEUS Database). The majority of the AMADEUS database entries are from not publicly traded companies. Due to the lack of available cost the capital information we focus on the Return on Capital Employed rather than EVA.

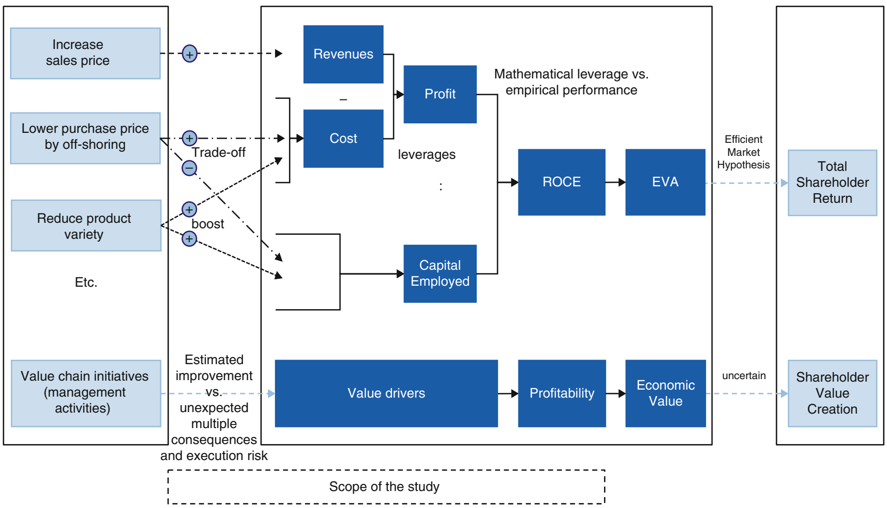

Fig. 1 The framework of shareholder value creation

2 Literature Review

There is an extensive and diverse body of literature on shareholder value creation. In the course of this research, 87 studies from 1994 to 2010 were reviewed. We present an overview of the studies' key findings that are relevant to this study in this section. The selection of the articles is based on the article by Lueg and Schäffer (2010), who reviewed 120 studies. Furthermore a search was conducted in the WISO, EBSCO and SSRN databases. Finally, an additional Google search was conducted. Studies of sectors other than manufacturing, as well as studies concentrating on single organizations were excluded from this research. We categorize the literature into three major research subjects addressing different areas of the process of value creation, as illustrated in Fig. 2.

2.1 Findings on Performance Measurement

Thirty-two reviewed studies focused on which performance measurement is most relevant to measure shareholder value creation (e.g. Ferguson et al. 2005; Fernández 2001; Biddle et al. 1999). Most studies examined correlation between performance metrics and stock prices. Main subject of most of these studies was the EVA concept by Stern Stewart. The findings on this subject differ widely. Fifteen studies consider value driven performance measures like the EVA or MVA superior to traditional performance metrics (e.g., Lueg 2010; Goedhart et al. 2005; Hall and Brummer 1998; Stark and Thomas 1998). In contrast, 17 research papers cannot confirm an improved measurement (e.g., Tortella and Brusco 2003; Fernández 2001; Olsen 1999) or confirm the opposite (e.g., Erasmus 2008; Mölls and Strauß 2007; Kröger 2005; Kramer and Pushner 1997). The quest for value led to a broad variety of concepts measuring the profitability of a business and the value created with an even greater variety of metrics. The strong emphasis on metrics in research and practice has been widely criticized. Articles such as "Metric Wars" (Myers 1996), "Putting value back in value-based management: VBM programs focus too much on measurement and too little on the management activities that create shareholder value" (McKinsey 2004) illustrates an example of that criticism. However, 15 studies analysed the value-based management concepts and metrics that companies use (e.g., Weber 2009; Fischer and Rödl 2005; Weaver 2001; Pellens et al. 1997). The studies show the broad variety of metrics that are used in practice. Nine studies examined the current state of value reporting (e.g. PricewaterhouseCoopers and Kirchhoff Consult AG 2006; Ruhwedel and Schultze 2002; Coleman and Eccles 1997).

2.2 Findings on Performance Reports

Numerous financial performance rankings are published, usually by advisory firms. Note that these studies differ enormously in scope, quality and metrics used. The quality ranges from trade magazines such as Forbes to scientific articles in peer

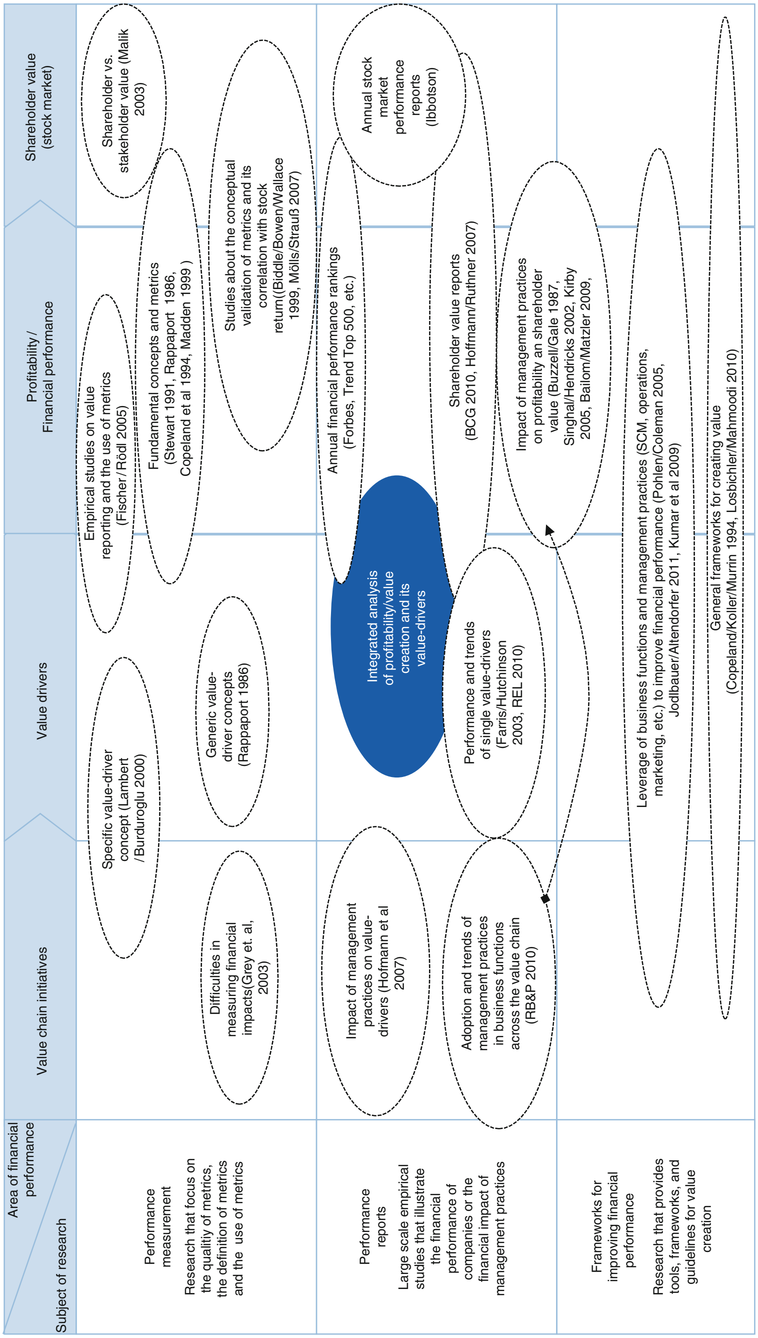

Fig. 2 Categories of existing research relative to this article

reviewed journals. The scope varies from a long-term scientific examination of a single value driver (e.g. C2C-cycle), annual listings of reported financial ratios, to shareholder value reports. Five studies were conducted (mostly with an annual update) where value creation is at least one of the important factors for ranking (e.g., The Boston Consulting Group 2010; Böschen and Palan 2010; Pellens et al. 2000; KPMG 2009; Kirchhoff Consult AG 2009; Hoffmann and Ruthner 2007).

Thirteen studies analysed value drivers, but only in a descriptional way (e.g., Bailom and Matzler 2009; Hammann et al. 2009; Fischer and Wenzel 2004; KPMG 2003; Ittner and Larcker 2001). The impact of value drivers on value creation or the linkage of value drivers are not usually the subject matters. Bailom and Matzler (2009) analysed the correlation of non-financial value drivers. They show that core competences and uniqueness are the most important factors to success. For the value driver "working capital" several studies (many designed as an annual panel) were conducted. The majority of these studies illustrate that the cash-to-cash-cycle-time did not improve in recent years even though the importance of working capital management is increasing (e.g. REL Consultancy 2010; PricewaterhouseCoopers 2009; Ernst and Young 2010; Losbichler and Rothboeck 2008; Farris and Hutchinson 2003). REL argues that 2009 was the worst year in working capital management since this study has been published. Several studies examined the link between a corporate function or management activities and profitability or shareholder value. For example, Singhal and Hendricks (2002) demonstrated a direct link between supply chain excellence and stock prices. The most prominent findings in this area were made by PIMS (Buzzell and Gale 1989).

However, we did not find studies that analysed profitability, its value drivers, and the linkage among the value drivers in an integrated approach. Following publications related to the presented paper most closely:

- The PWC study (2004) showed, that working capital is negatively correlated with the EBIT-margin and therefore with ROCE (Wagner and Grosse-Ruyken 2010; Meyer and Lüdtke 2006). Little (2006) illustrated a negative correlation of the Cash Conversion Cycle with the firm value as well.
- BCG's annual Value Creators Report disaggregated total shareholder return for a worldwide sample of companies in five different value drivers, whereas two value drivers "revenue growth" and "profit margin" were also used in the present article. Yet BCG focused on stock prices and did not publish correlation of value drivers.
- The REL-study examined ROCE, Revenue growth, profit margin and C2C-cycle. Thus, the study provided the most overlap. Unfortunately, REL provided data only for the largest US-1000 companies and did not examine correlations and establish research questions.

2.3 Findings on Frameworks for Improving Financial Performance

A variety of articles demonstrated the leverage of certain management practices or business functions to improve financial performance and value creation. In particular, the studies focused on supply chain management, operations management and logistics management provided frameworks to quantify the impact on financial ratios (Jodlbauer and Altendorfer 2011). Finally a small number of publications demonstrate general frameworks for improving profitability or creating shareholder value. In particular, the McKinseys Diamond-approach (Copeland et al. 1994), and BCG's C-Curve-Framework. Timme and Williams-Timme (2000) proposed a three-step approach while Losbichler and Mahmoodi (2010) offered a five-step approach.

2.4 Impact on this Paper

Several advisory firms conducted empirical studies on value-based management, value drivers and financial performance. In contrast, academic research primarily addressed integrated, long-term analysis of profitability and value drivers, while studies focusing on the linkages among those drivers were rare.

In today's complex, far-flung supply chains, management activities have multiple consequences many of them unintended. For example, lower unit costs as a result of off-shoring can be offset by an increase in lead time and higher inventory carrying costs. It may be the case that the source with the lowest unit cost does not have the highest impact on profitability (Ferreira and Prokopets 2009). On the other hand, reducing cost by lowering product variety will not only lower the operating cost but also the inventory and working capital. Managerial decisions often simultaneously affect more than one value driver. In fact, they involve trade-offs between revenues, costs and assets. Thus, utilizing profitability ratios can help managers extract greater value and the integrated empirical analysis of all value drivers can unveil important findings to improve profitability.

The objective of this study is to analyse the success of European manufacturing companies' efforts to grow and to improve ROCE, to analyse which value drivers they used effectively, to investigate whether value drivers can be affected independently, and to analyse the interplay among the value drivers. Thus, our empirical study examines five research questions:

RQ1. *Have selected European companies been successful in managing profitable growth as measured by Return on Capital Employed?*
RQ2. *Can significant differences between the analysed sectors be observed in terms of Return on Capital Employed?*
RQ3. *Which basic drivers were effectively by these companies during the observation period?*
RQ4. *Are European manufacturing companies able to influence selected value drivers independently or can we find significant correlations between these value drivers?*
RQ5. *Which basic value drivers show the best leverage on ROCE?*

3 Pitfalls in Interpreting Corporate Profitability

3.1 *The Difficulties of Interpreting Profitability Data*

Profitability in its most general form is calculated by dividing a company's earnings by the capital required to generate them. In practice a large variety of metrics and definitions are utilized. However, the term Return on Capital Employed has become very popular in recent years (Fischer and Rödl 2005) (Fig. 3).

Due to this variety, great care must been taken in measuring and interpreting profitability data. There is a danger of comparing apples with oranges. Thus we do not compare the results of our study with existing studies and attention should be paid to the components that are included or excluded in interpreting profitability ratios. It is important to note that there is not one best metric. The best definition very much depends on the type of decision that should be supported by the metric. In one case management may be interested in knowing the profitability of its operating core business, while in another case investors may be interested in the net profitability in a given period, regardless of whether that profitability has resulted from the core business or one-off effects. However, it is important to ensure consistency between the numerator and the denominator and to select the matching items of the income statement and the balance sheet. For example, the most common definition of the ROA (net profit divided by total assets) does not make any sense. The ROA can neither be compared with the WACC, due to the fact that interest for debt is already deducted, nor can it be compared with the cost of equity because the cost of equity is caused by equity rather than total assets (Fig. 4).

3.2 *Shortcomings of Profitability Metrics and Limitations of Our Study*

Unfortunately profitability ratios have several shortcomings that managers and researchers should keep in mind when analysing and interpreting ROCE-figures.

- ROM – Return on Investment
- ROC – Return on Capital
- ROA – Return on Assets
- ROOA – Return on Operating Assets
- RONA – Return on Net Assets
- RONOA – Return on Net Operating Assets
- ROTC – Return on Total Capital
- ROTGA – Return on Total Gross Assets
- ROCA – Return on Controllable Assets
- ROIC – Return on Invested Capital
- ROGIC – Return on Gross Invested Capital
- CFROI – Cashflow Return on Investment
- ROR – Raise of Return
- RORAC – Return on Risk Adjusted Capital
- RAROC – Risk Adjusted Return on Capital
- ROCE – Return on Capital Employed

Fig. 3 Profitability metrics can differ

Most importantly ROCE is an accrual accounting metric and thus subject to accounting decisions and reporting dates. First, attention should be paid to the effects of whitewashing the balance sheet such as leases, factoring or targeted reduction of stock at the balance sheet date to lower the denominator and magnify ROCE. Many times improvement occurs only before performance is reported, as illustrated in Fig. 5 (Working Council for Chief Financial Officers 2004).

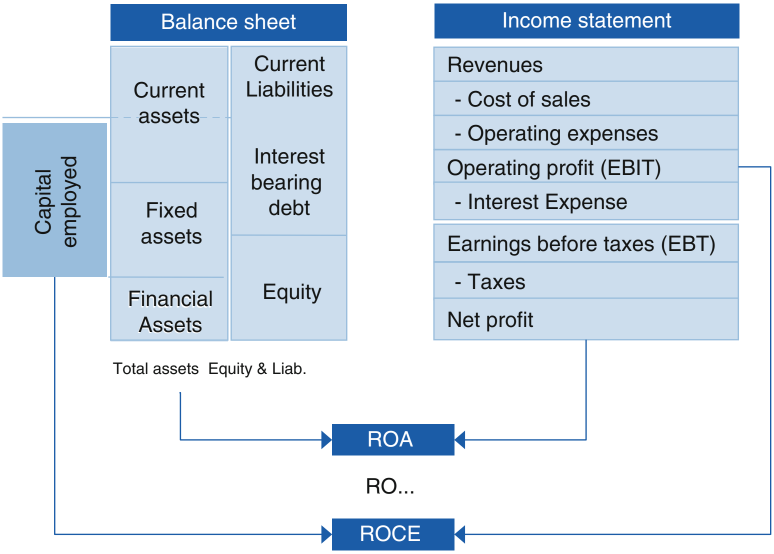

Fig. 4 Profitability as a selection of matching income-statement and balance sheet items

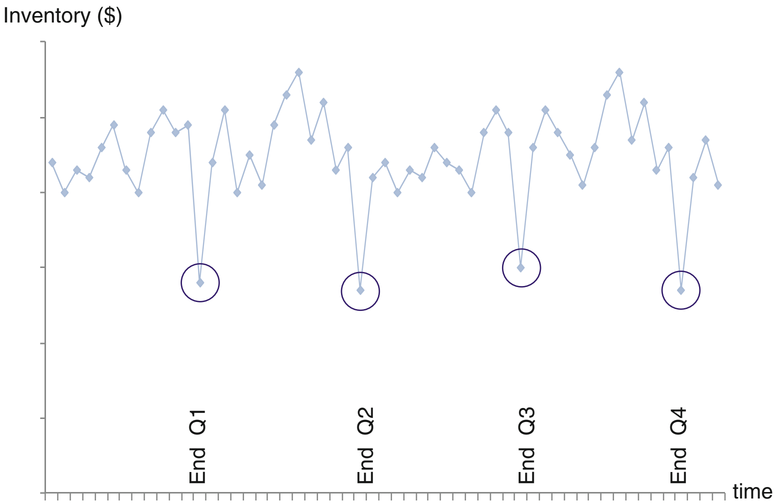

Fig. 5 Whitewashing the balance sheet at reporting dates to magnify profitability

Whitewashing can also happen unwittingly. For example, some companies use direct debit and collect cash from customers at the end of the month. Thus, accounts payable equals zero at the reporting date.

Second, accounting principles differ in European countries. The extent of these differences and its impact on financial ratios have been widely published (Wagenhofer 2005). Even within the same accounting standard companies may choose different methods of recognizing business transactions and valuing assets and liabilities. Finally, ROCE-Figures are significantly impacted by financing decisions such as leases and the age of the company's assets. Rappaport provides a comprehensive overview about the shortcomings of ROCE in his ground-breaking book *Creating Shareholder Value* (Rappaport 1986).

Note that the limitations listed above may occur but don't necessarily have to. In particular, in a long-term analysis as conducted in this paper, the impact of accounting decisions is almost eliminated, due to the requirement to stick to valuation principles. Furthermore, if the same whitewashing takes place every year, trends are not distorted, particularly when the median of large-scale data is published. However, the results remain subject to changes in accounting standards.

4 Data and Method

4.1 ROCE-Framework

We use a common operating definition of ROCE to avoid distortions from interest and taxes. In the numerator we use the operating profit. This is the profit before interest and taxes (EBIT). The capital employed should only represent the interest bearing capital employed. Thus, ROCE could be measured against the Weighted Average Cost of Capital before taxes (Losbichler and Engelbrechtsmüller 2010). In general, Capital Employed can be determined from both sides of the balance sheet as illustrated in Fig. 6.

Determining capital employed from the "capital"-perspective or the right side of the balance sheet makes calculations simple. Equity and interest bearing liabilities, such as long-term debt are added together. The nature of pension and payroll related liabilities are considered differently in literature (Lewis 1994; Weißenberger 2009). However, this approach has two major shortcomings. First, it is difficult to understand for managers who are not financial experts. More importantly, it is almost impossible to break down Capital Employed into its useful value-drivers. The amount of assets that is required for doing business induces the amount of equity and liabilities and not vice versa. Capital employed can only be managed effectively if assets are controlled and monitored. Third, this approach makes it difficult to determine the net amount that is really tied up in the operating business. For example, it would be possible to deduct financial investments (that is not tied up in the operating business) from the total of equity and interest bearing liabilities. However one may find it difficult to determine if these financial assets were financed with interest bearing and non-interest bearing capital.

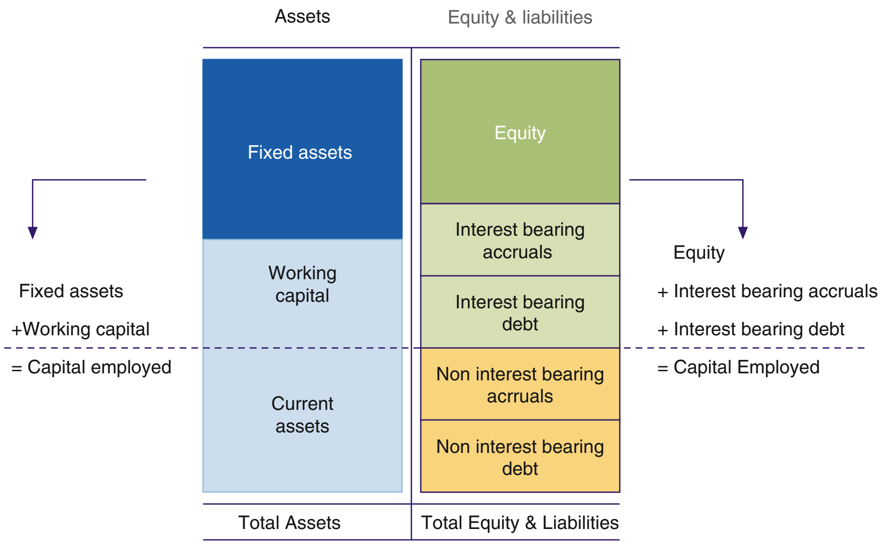

Fig. 6 Determining capital employed from two different perspectives

In our opinion, determining capital employed from the perspective of assets is the more appropriate approach. In the first step those assets are selected that are tied up in the operating business. For example, financial investments, marketable securities, financing receivables, or deferred taxes may be excluded. In the second step, non-interest bearing capital that is related to the operational business, such as accounts payable is being deducted so that the net amount of assets is left that causes the cost of capital. This approach disaggregates capital employed into its value drivers and appeal to managers at the core of their business.

Note that the accuracy of determining capital employed as the amount that is tied up in a company's operational business which has to be financed with interest bearing capital is limited by the available published data. In our case we rely on the level of disaggregation of the AMADEUS database. The AMADEUS database publishes balance sheet items as follows.

Based on the available data, we determine capital employed as follows (data used for calculation of ROCE and its drivers is marked in bold letters in the income statement and balance sheet in Fig. 7):

$$\mathrm{ROCE} = \frac{\mathrm{EBIT}}{\mathrm{Capital\ Employed}} = \frac{6,463}{36,702} = 17.6\%$$

$$\begin{aligned}
\text{Capital Employed} &= \text{Net fixed assets} + \text{Working capital} = 24,921 + 11,781 \\
&= 36,702 \\
\text{Net fixed assets} &= \text{Tangible fixed assets} + \text{Intangible fixed assets} \\
&= 9,889 + 15,032 = 24,921 \\
\text{Working Capital} &= \text{Stock} + \text{Debtors} - \text{Creditors} = 6,763 + 7,752 - 2,734 \\
&= 11,781
\end{aligned}$$

INCOME STATEMENT

Operating revenue	**63,608**
Sales	62,304
Costs of goods sold	46,455
Gross profit	17,153
Other operating expenses	10,690
Operating P/L [=EBIT]	**6,463**
Financial revenue	196
Financial expenses	683
Financial P/L	–487
P/L before tax	5,976
Taxation	2,671
P/L after tax	3,305
Extr. and other revenue	n.a.
Extr. and other expenses	n.a.
Extr. and other P/L	n.a.
P/L for period [= Net income]	3,305

BALANCE SHEET

Assets		Liabilities & Equity	
Fixed assets	28,014	Shareholders funds	18,722
- Intangible fixed assets	**9,889**	- Capital	1,176
- Tangible fixed assets	**15,032**	- Other shareholders funds	17,546
- Other fixed assets	3,093		
		Non-current liabilities	19,583
Current assets	22,846	- Long term debt	9,044
- Stock	**6,763**	- Other non-current liabilities	10,539
- Debtors	**7,752**	* Provisions	10,539
- Other current assets	8,331		
* Cash & cash equivalent	2,776	Current liabilities	12,555
		- Loans	6,224
		- Creditors	**2,734**
		- Other current liabilities	3,597
TOTAL ASSETS	50,860	TOTAL SHAREH. FUNDS & LIAB.	50,860

Fig. 7 AMADEUS database for BASF group report 2008 in million €

Ratio	Formula	Profit	Capital	Profitability
ROCE (our study) =	$\frac{\text{EBIT}}{\text{Capital Employed}}$	6,463	36,702	17.6%
ROCE (REL study) =	$\frac{\text{EBIT}}{\text{Total Assets - Creditors}}$	6,463	48,126	13.4%
ROA =	$\frac{\text{P/L after tax}}{\text{Total Assets}}$	3,305	50,860	6.5%

Fig. 8 Spread of BASF's profitability due to different ratios or formulas

As already discussed before, in this study we measure the operating profitability that may vary from other studies or reported figures. Figure 8 illustrates the variation of different approaches.

4.2 Value Drivers Defined

The Return on Capital Employed can be improved by its basic drivers: revenues, costs, and capital employed. Note that it is better to break down capital employed into fixed assets and working capital. This allows the analysis of the trade-offs between lower inventory and higher equipment efficiency in the case of manufacturing companies (Losbichler and Mahmoodi 2010). As a result, ROCE can be increased by four basic value drivers:

- Higher revenues measured by revenue growth;
- Lower cost measured by operating profit margin;

- Lower fixed assets measured by fixed asset turnover; and
- Lower working capital measured by cash-to-cash (C2C) cycle time.

Revenue growth is an indicator of the pace at which a company is able to grow its revenues during 1 year. It is the year-over-year increase of a company's revenues, expressed as a percentage. The higher the growth rate, the faster a company grows in revenues. Top-line growth can be accomplished in general by an increase in selling volume or advanced prices or a combination of both.

$$\text{Revenue Growth} = \frac{\text{Revenues}_{2008}}{\text{Revenues}_{2000}} = \frac{63,608}{37,361} = 170.3\%$$

The operating profit margin measures the profit per Euro sales remaining after deducting all operating expenses. It is calculated by dividing operating profit by revenues. The operating profit margin is an indicator of a company's ability to control costs in relation to revenues. It measures the operating core business, excluding effects of investments, financing and taxes.

$$\text{Operating profit margin} = \frac{\text{Operating profit}}{\text{Revenues}} = \frac{6,463}{63,608} = 10.2\%$$

The fixed asset turnover measures the relationship between a firm's revenues and the fixed assets needed to sustain this level of operation. It primarily analyses how effectively a firm uses its plant and equipment to generate sales. In the case of growth strategies the fixed asset turnover can also be used to forecast the required investments for a projected sales level. The fixed asset turnover is affected from a company's financing policy (e.g. leases), its vertical integration and the nature of its industry.

$$\begin{aligned}\text{Fixed asset turnover} &= \frac{\text{Revenues}}{\text{Net fixed assets}} = \frac{\text{Revenues}}{\text{Intangible assets} + \text{Tangible fixed assets}}\\ &= \frac{63,608}{9,889 + 15,032} = 2.55\end{aligned}$$

The C2C-cycle time is a composite metric describing the average days required to turn a Euro invested in raw material into a Euro collected from a customer. It measures how effectively working capital is managed and how long capital is tied up by a company's operating business. The C2C-cycle time is equal to Days Sales in Inventory (DSI), plus Days Sales Outstanding (DSO), minus Days Payables Outstanding (DPO), as illustrated in Fig. 9.

$$\text{C2C} - \text{ CycleTime} = \text{DSI} + \text{DSO} - \text{DPO} = 38.8 + 44.5 - 15.7 = 67.6$$

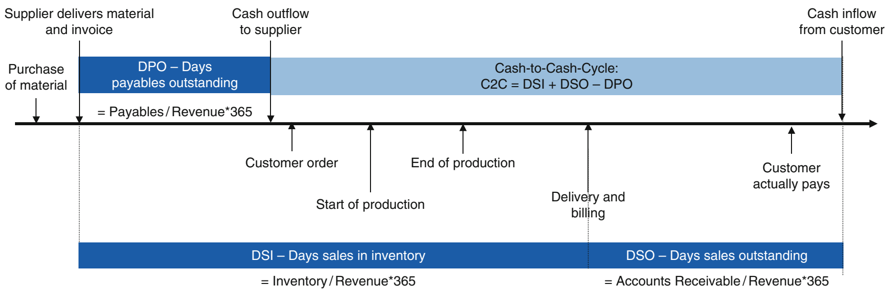

Fig. 9 Cash-to-cash cycle time calculation

$$\mathrm{DSI} = \frac{\text{Stock} * 365}{\text{Revenues}} = \frac{6,763 * 365}{63,608} = 38.8$$
$$\mathrm{DSO} = \frac{\text{Debtors} * 365}{\text{Revenues}} = \frac{7,752 * 365}{63,608} = 44.5$$
$$\mathrm{DPO} = \frac{\text{Creditors} * 365}{\text{Revenues}} = \frac{2,734 * 365}{63,608} = 15.7$$

4.3 Data

This study is based on data from approximately 250,000 European companies available in the AMADEUS database. We have included only those companies whose datasets are complete and therefore, related to the variables above entirely cover the periods from 2000 to 2008. This restriction resulted into a reduced sample of 53,909 companies.

Since the main focus of our secondary research is based on value chain management of manufacturing companies, only datasets of manufacturing, mining and construction companies have been considered for further analysis. Thus, companies in industries such as wholesale and retail trade, transportation, agriculture, education, insurance, finance or non-profit-organizations have been excluded. Thus, a total of 23,489 companies have been investigated.

The present paper analyses the evolution of ROCE and its related value drivers for these European manufacturing companies. Additional focus will also be given to the starting and ending period of our observation period. As especially the defined ending period 2008 was the beginning of the economic crises caused by the collapse of the financial markets and therefore resulting in extraordinary data, analysis especially on trends by means of linear regression will be established in the interval 2000–2007. Other financial crisis like the rise and fall of internet companies manifested in the dot.com crash in our survey starting in 2000 is not considered as this study concentrates on manufacturing companies and therefore this impact is not significant.

4.4 Method

Our empirical study examines five research questions. We use annual growth rates to analyse the evolution of our basic value drivers: Operating Profit Margin, Asset Turnover, C2C-cycle and Revenue Growth and the performance measure ROCE. Multiple linear regression is additionally used to investigate the link between these value drivers and ROCE. The degree of relationship among the value drivers is analysed by utilizing correlation analysis. As indicated in our research questions above, comparisons with other branches like agriculture, transport, wholesale and retail trade shall be established. The classification of sectors, which is used by AMADEUS database, is achieved by the American Standard-Industry-Classification-Code (SIC). This code will not only allow us to compare different European sectors, but classifies the resulting data for further analogies with US-companies and sectors. Additionally selected companies shall also be clustered for further empirical investigations by enterprise size and European region.

5 Results of the Empirical Study

Our first research question focuses on the relationship between revenue growth and performance measurement of European manufacturing firms.

RQ1: Have selected European companies been successful in managing profitable growth measured by Return on Capital Employed?

We draw the following result from the applied study shown in Fig. 10.

The companies included in the sample show a steady revenue-growth in median level during the observation period. This growth is characterized by an annual growth rate of 6.07% from 2000 to 2008 (excluding 2008 annual growth rate results in 6.79%). We have to take into consideration that this growth includes an average rate of inflation of 2.6%. The annual growth rate for net revenues would therefore result in 3.47% (4.19% excluding 2008 respectively).

Despite this growth, manufacturing companies were unable to manage an increase in ROCE simultaneously. The median ROCE decreased for the selected sample from 10.8% in 2000 by 2.7 base points to 8.1% in 2008, corresponding to an annual compound growth rate of −0.34%. If we again exclude the ending period 2008 driven by extraordinary data content as mentioned before, annual compound growth rate of ROCE derives in −0.05%.

The fact that sample European manufacturing companies are not able to achieve profitable growth is also illustrated by yearly median ROCE and revenue movements in Fig. 11.

Based on these results further detailed analysis of ROCE has to be conducted. As indicated above, clustering in different enterprise sizes and European region shall give more information about the evolution of return on capital measured by ROCE (Table 1).

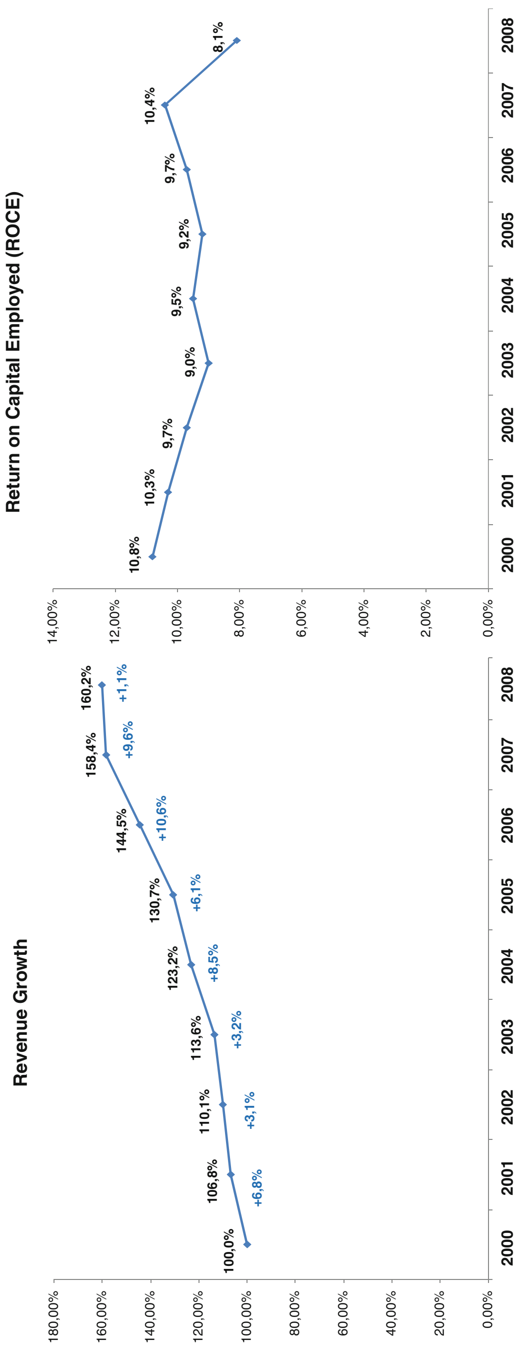

Fig. 10 Revenue growth and ROCE 2000–2008

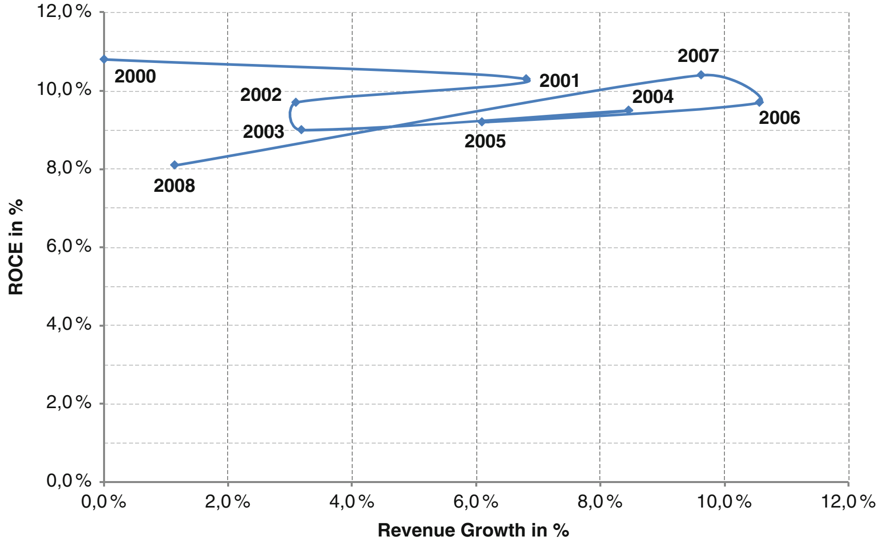

Fig. 11 Revenue growth and ROCE from 2000 to 2008

Table 1 Categories of enterprise size and composition of European regions

Category	Current revenues	Category	Countries
Micro	<2,000,000 €	Southern Europe	Italy, Spain, Portugal, Croatia, Serbia, Bosnia-Herzogoviana, Greece, Albania
Small	<0,000,000 €	Western Europe	Great Britain, Ireland, France, Netherlands, Belgium, Luxemburg
Middle	<50,000,000 €	Central Europe	Germany, Switzerland, Austria, Poland, Hungary, Slowakia, Slovenia, Czech Republic
Large	≥50,000,000 €	Northern Europe	Norway, Sweden, Finland, Estonia, Latvia, Lithuania
		Eastern Europe	Russia, Bulgaria, Rumania, Belarus, Ukraine

Figure 12 illustrates the evolution of ROCE on median level related to the size of the enterprise and European regions. The first figure of Fig. 12 shows significant distinctions in ROCE based on the different enterprise sizes. Whereas large and middle companies show continuous returns on capital of around 10–11%, smaller companies show a median level in the range of 4–6%. The investigation of ROCE of micro companies' results is even worse, their performance decreases from 4–5% per year to 0% in 2008.

The second figure of Fig. 12 provides additional information about the return on capital of defined European regions, as shown in Table 2.

Excluding the year 2008, significant trends can be detected in the period 2000–2007. While the annual median performance of Eastern and Central European companies increased by 0.35% and 0.40% respectively, the median

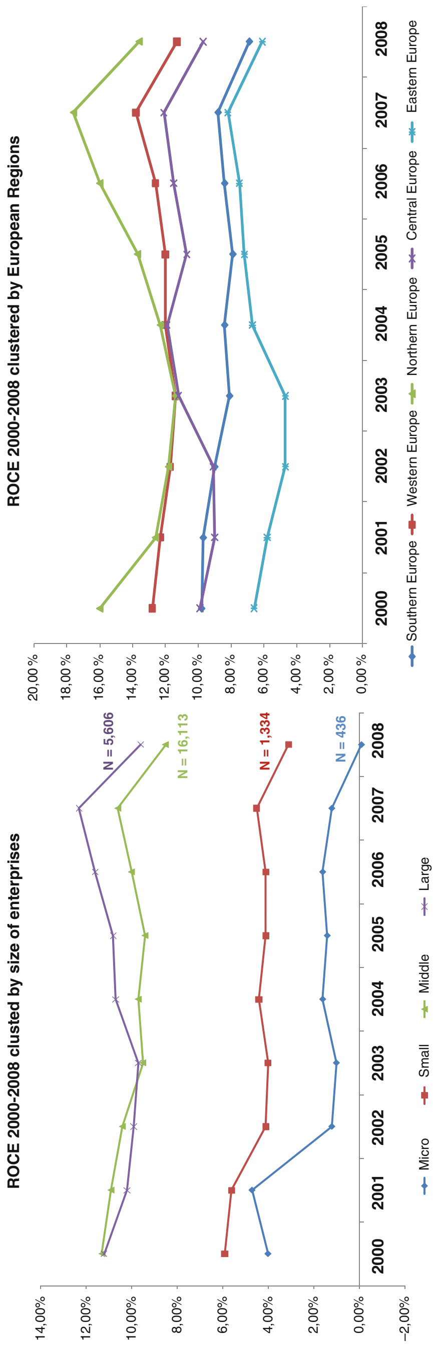

Fig. 12 ROCE 2000–2008 clustered by size of enterprise and European regions

Table 2 Median ROCE for European regions 2000–2008

Country	N	2000	2001	2002	2003	2004	2005	2006	2007	2008
Southern Europe	13,412	0.098	0.097	0.090	0.081	0.084	0.079	0.084	0.088	0.069
Western Europe	7,691	0.128	0.123	0.117	0.114	0.120	0.120	0.126	0.138	0.113
Northern Europe	1,253	0.160	0.126	0.118	0.114	0.123	0.137	0.160	0.176	0.136
Central Europe	477	0.099	0.090	0.091	0.112	0.119	0.107	0.115	0.121	0.097
Eastern Europe	656	0.066	0.058	0.047	0.047	0.067	0.072	0.075	0.082	0.061
Europe	23,489	0.108	0.103	0.097	0.090	0.095	0.092	0.097	0.104	0.081

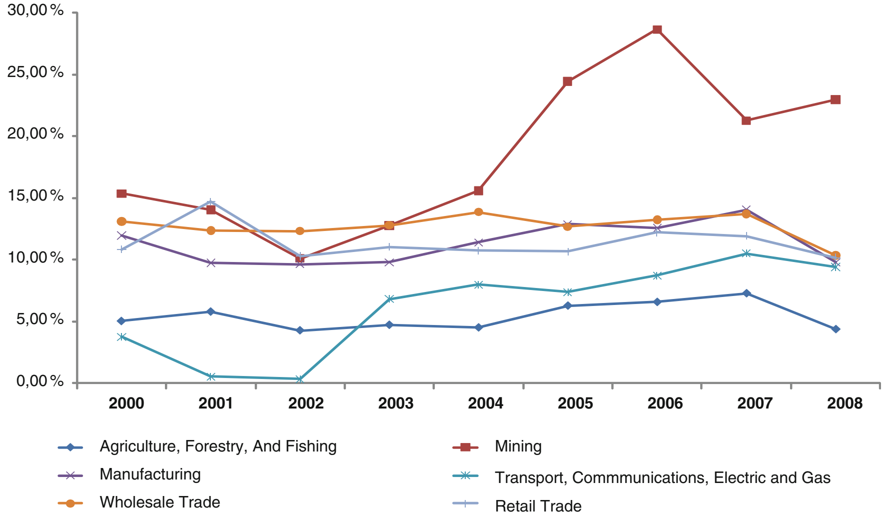

Fig. 13 ROCE sectors 2000–2008

performance of Southern European companies decreased by −0.20%. For evolution of ROCE of Western and Northern Europe no significant trends can be analysed.

Up to now our study has focused on the evolution of ROCE for manufacturing companies, giving further information by clustering in different enterprise sizes and European Regions. By means of secondary research the paper also intends to compare producing industries Manufacturing (N = 18,456), Mining (408) and Construction (4,625) with other industries like Agriculture (598), Transportation (4,010), Wholesale (13,392) and Retail Trade (3,366). The following second research question is investigated in our study.

RQ2: Can significant differences between the analysed sectors be observed in terms of Return on Capital Employed?

Figure 13 provides an overview of the sector related return on capitals.

By investigating the ROCE-evolution of different European sectors, important trends and differences can be found. Sectors like mining and transportation show significant growth in their performance, mining companies increase their performance from 15.4% ROCE in 2000 to 23.0% in 2008 and turn out to be best

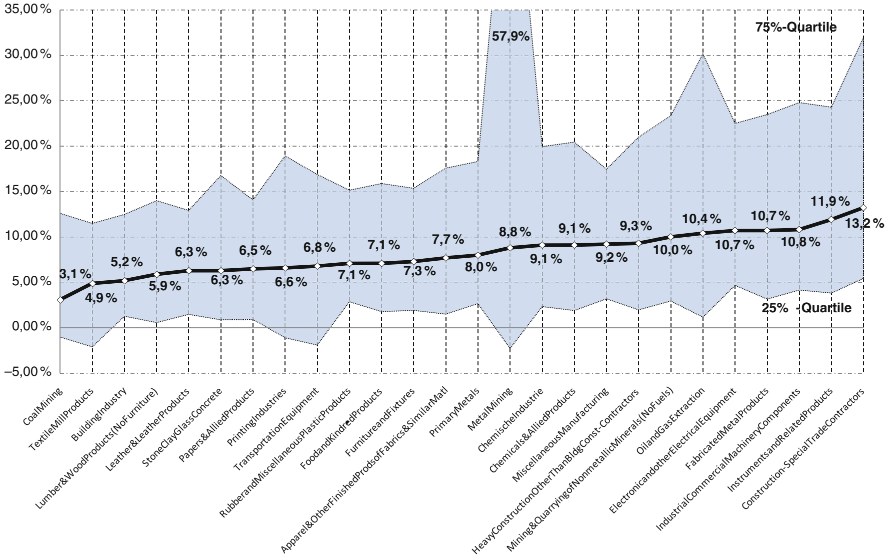

Fig. 14 ROCE 2008 of European manufacturing subbranches

sector on median level in 2008. Other sectors like manufacturing, retail and wholesale trade have not increased their performance in the related timeframe and therefore transportation sector with its increase in ROCE of 5.6% (3.8% in 2000, 9.4% in 2008) can finally make up the gap still existing in the first years of our observation period. Further analysis also shows time-delayed evolutions of the chosen industries of our study. Mining companies achieve their median ROCE-maximum after steady growth already in 2006, other sectors like manufacturing, wholesale trade or transportation reach their performance peaks only in 2007. Similar trends can also be observed for the impact of the economic crisis. While the performance of mining sector declined in 2007, all other sectors' ROCE decreased in 2008, primarily due to the financial crisis.

These significant differences in performance can also be illustrated by analysing subsectors of manufacturing companies. Figure 14 provides an overview of median ROCE-spread in 2008, also compared to 25%- and 75%-quartiles per sub-industry. The valuation range of ROCE with a spread of 10.1% is caused by the coal mining sector (3.1%) on the left hand of the performance-interval respectively Construction Special Trade Contractors on the right hand (13.2%).

Further information on the evolution of the performance of selected manufacturing subsectors gives Table 3. It shows the average yearly growth of ROCE, calculated in the full observation period 2000–2008, as well as during the period 2000–2007, to exclude the impacts of the financial crisis in 2008. This investigation of subsectors regarding ROCE-evolution in 2000–2007 confirms the analysed positive trend for the mining industry, also shown in Fig. 13. This reveals that coal-, metal- and non-metallic mineral mining are the three mining subsectors on the Top 5 list.

Table 3 Top 5 best and worst subbranches regarding performance evolution

Branche_SIC	2000 (%)	2008 (%)	Delta 00_08 (%)	Average delta (%)	2000 (%)	2007 (%)	Delta 00_07 (%)	Average delta (%)
Leather and leather products	11.10	6.30	−4.80	−0.60	11.10	6.70	−4.40	−0.63
Furniture and fixtures	13.80	7.30	−6.50	−0.81	13.80	9.90	−3.90	−0.56
Apparel and other finished prods. of fabrics and similar matl.	13.00	7.70	−5.30	−0.66	13.00	10.00	−3.00	−0.43
Printing industries	12.20	6.60	−5.60	−0.70	12.20	9.50	−2.70	−0.39
Rubber and miscellaneous plastic products	12.20	7.10	−5.10	−0.64	12.20	9.80	−2.40	−0.34
Instruments and related products	11.40	11.90	0.50	0.06	11.40	13.90	2.50	0.36
Coal mining	4.10	3.10	−1.00	−0.13	4.10	7.20	3.10	0.44
Primary metals	9.60	8.00	−1.60	−0.20	9.60	12.70	3.10	0.44
Mining and quarrying of nonmetallic minerals (no fuels)	12.00	10.00	−2.00	−0.25	12.00	15.30	3.30	0.47
Metal mining	8.50	8.80	0.30	0.04	8.50	12.90	4.40	0.63

After analysing the performance evolution of European manufacturing companies and comparing them with other sectors, we next focus on the development of the related value drivers during the chosen time-frame. The following third research question is now addressed:

RQ3: Which basic drivers were used effectively by these companies during the related observation period?

Figure 15 provides an overview of the development of the chosen value drivers during the 2000–2008 period:

Operating Profit Margin of European manufacturing companies shows no significant trend between 2000 and 2008. In fact, it decreases from 4.7% to 4.0%. The average performance in our reduced interval 2000–2007 is flat, as 2007 with median OPM of 4.7% is equal to starting point 2000.

Despite the steady significant growth of revenues by an annual average rate of 6.1%, Operating Profit Margin remains fairly flat. This clearly indicates that companies have increased total costs to the same extent to which revenues grew, resulting in no profitable growth during the observation period.

By investigating fixed asset turnover of European manufacturing companies we have to take into consideration the change in asset accounting of Italian companies in 2008, which caused an increase in fixed assets and therefore reduced the median asset utilization in that year. The observed trend, which shows an increase in fixed asset turnover of 0.21 (from 6.06 in 2000 to 6.27 in 2008) was intensified by excluding Italian companies from our sample. After eliminating this accounting impact we can observe a fixed asset turnover growth of 0.73 (from 6.11 to 6.84).

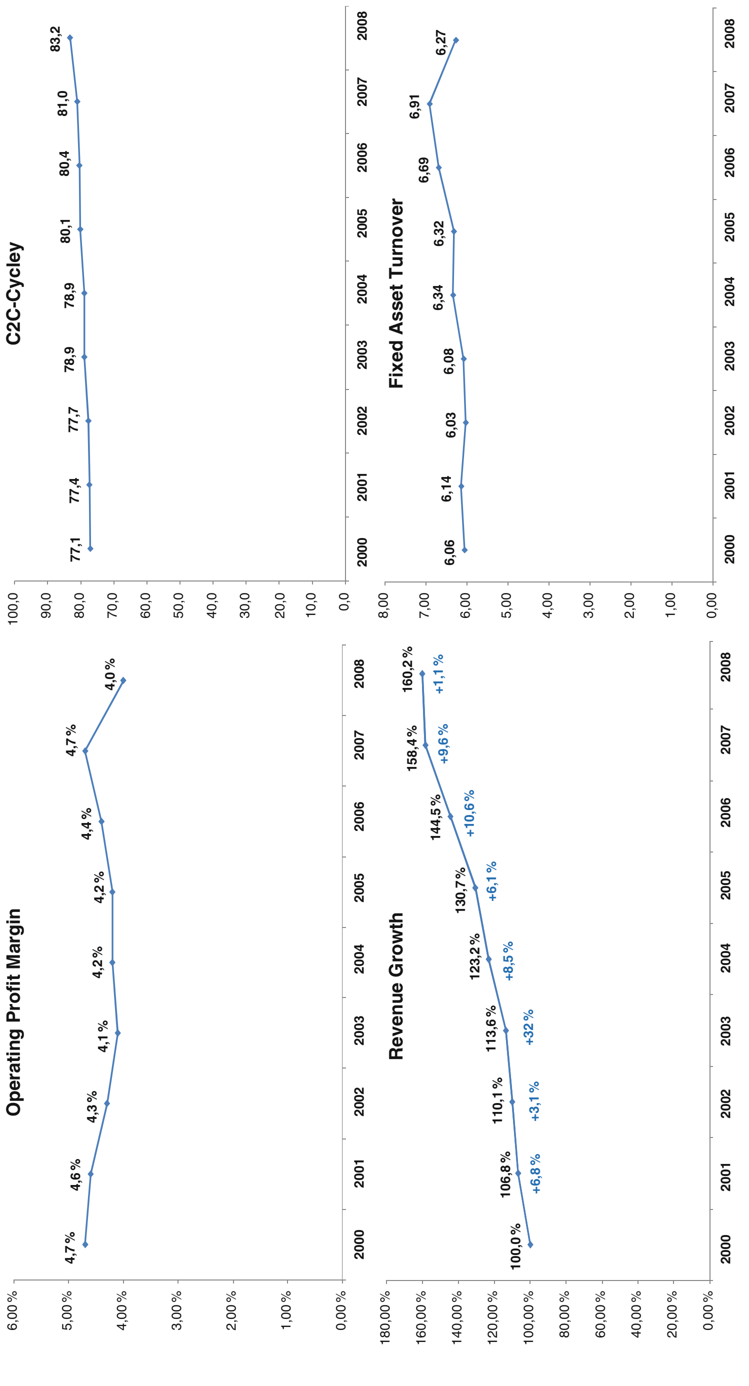

Fig. 15 Evolution of operating margin, revenue growth, C2C-cycle, Fixed Asset Turnover

Analysis of the related C2C-cycle resulted in no sustainable improvements of this basic value driver, despite the intensive discourse over Working Capital management in theory and practice. The median level of Cash-to-cash Cycle grew for the entire sample from 77.1 days in 2000 to 83.2 days in 2008, resulting in an annual growth of 0.77 days. This trend can also be confirmed by breaking down the C2C-cycle into DSI, DSO and DPI components. Figure 16 displays this further detail, showing steady increases in DSI from 2000 to 2008 and similar trends for DSO and DPO from 2000 to 2007.

Besides the evolution of each single value driver our study emphasizes the relationship among our chosen value drivers. We have therefore computed the firm-specific time-series means for each value driver and for the related performance measure ROCE in first step and have thereafter aggregated these means by the criteria subsector and company size. By means of correlation RQ4 shall be answered, based on the derived sample of 94 time-series means per value driver:

RQ4: Are European manufacturing companies able to influence selected value drivers independently or are there significant correlations among these value drivers?

Pearson's correlation coefficient $\boldsymbol{\rho_{X,Y}}$ is used for the calculation of correlation between the linear relationship of value drivers, which is defined as follows:

$$\rho_{X,Y} = corr(X,Y) = \frac{cov(X,Y)}{\sigma_X \sigma_y} \quad \text{X, Y : Random Variables (Value Drivers)} \quad (1)$$

$$\sigma_X, \sigma_y : \text{Standard deviation of X and Y}$$
$$cov(X,Y) : \text{Covariance of X and Y}$$

Table 4, which is based on the aggregated time-series means of our observation period for our selected value drivers, provides the calculated Pearson's correlation coefficients. As the direction of association is not known in advance, two-tailed probabilities have been selected to test the significance of correlations. The results of Table 4 show significant positive correlations between Revenue Growth and Operating Profit Margin, between Revenue Growth and Fixed Asset Turnover and between Fixed Asset Turnover and Operating Profit Margin. No significant correlation is observed for average Revenue and C2C Growth, for C2C- and Fixed Asset Turnover Growth and for average C2C- and Operating Margin Growth.

The highly significant correlation of 0.59 between average Revenue Growth and average Operating Profit Margin growth shows on the one hand that companies do not raise operating margin in the same extend as revenues due to a large share of variable costs. On the other hand, compared to overall-results of highly aggregated median data, where no correlation between Operating Profit Margin and Revenue Growth can be found, this positive correlation shows that certain subsectors have not increased their total costs in the same extend as their revenues.

Similar significant results can be observed for Revenue Growth and Fixed Asset Turnover, which positively correlate by 0.45, indicating that companies were

Table 4 Correlation of aggregated average growth for value drivers on median level

		Average_Revenue_Growth	Average_C2C	Average_Fixed_Asset_Turnover	Average_Operating_Margin
Average_Revenue_Growth	Correlation by Pearson	1			
	Level of significance (two-tailed)				
	N	94			
Average_C2C	Correlation by Pearson	−.140	1		
	Level of significance (two-tailed)	.179			
	N	94	94		
Average_Fixed_Asset_Turnover	Correlation by Pearson	.451[a]	−.098	1	
	Level of significance (two-tailed)	.000	.347		
	N	94	94	94	
Average_Operating_Margin	Correlation by Pearson	.587[a]	.046	.258[b]	1
	Level of significance (two-tailed)	.000	.661	.012	
	N	94	94	94	94

[a]Correlation is significant on a level of 1%
[b]Correlation is significant on a level of 5%

partially successful in managing their investments simultaneously to revenue increases.

This successful management of investments results as well in improved profit margins, empirically shown by a positive correlation between fixed asset turnover and revenue growth of 0.26 at a significance level of 1.2%.

The final investigation of our study focuses on the impact of the chosen value drivers on the ROCE metric. By examining research question 5 our study reveals significant links between the value drivers considered and the ROCE metric.

RQ5: Which basic value drivers show the best leverage on ROCE?

Multiple linear regression is utilized to investigate this question. The regression model is defined based on the dependent variable ROCE, whereby our basic value drivers OPM, C2C, Fixed Asset Turnover and Revenue Index represent the independent variables. We use the same database as described to answer RQ4, meaning median data level of aggregated time-series means by criteria subsector and company-size. The regression equation for dependent variable ROCE for each of the 94 datasets can therefore be illustrated by the following formula:

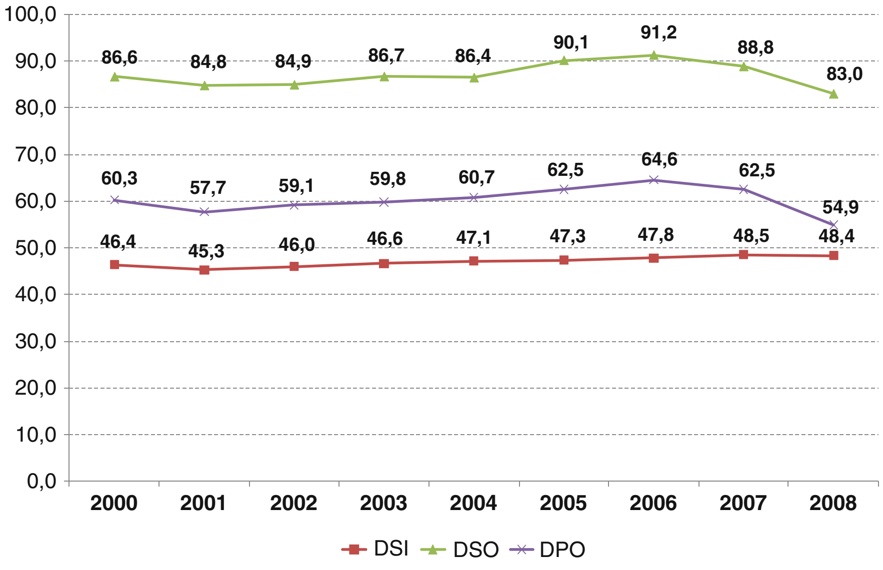

Fig. 16 Breaking down C2C-cycle into DSI, DSO and DPO components

$$ROCE_j = B_0 + \sum_{i=1}^{4} \mathrm{B_j} * \mathrm{V_j^i} + \mathrm{e_j} \qquad \mathrm{j} = 1, 2, \ldots, 94 \tag{2}$$

$\mathrm{V_j^i}$: Value Driver i of dataset j $\mathrm{B_o}$: Absolute Term

$\mathrm{B_j}$: Regression Coefficient j for Value Driver $\mathrm{V_j}$ $\mathrm{e_j}$: Error Term of dataset j

Based on the derived model data as described above requirements for multiple linear regression have been fulfilled. All variables are quantitative and the distribution of our dependent variable is normal. For entry and removal of variables a stepwise selection method was chosen, using 5% as entry significance level and 10% as removal value. Conducting stepwise regression analysis resulted in the regression coefficients shown in Table 5 respectively in the following model fit in Table 6, and finally derived in Eq. 3 for dependent variable ROCE:

$$ROCE = -\mathbf{0}.004 + 0.312 * \mathbf{OPM} + 0.019 * Asset\ Turnover + 0.028 * Revenue\ Growth \tag{3}$$

Equation 3 reveals that the value drivers OPM, Fixed Asset Turnover and Revenue Growth significantly influence dependent variable ROCE. The missing value driver C2C-cycle was not admitted in the independent variable list due to the lack of significance and therefore not passing the entrance hurdle rate. As expected all value drivers are positively correlated to ROCE. The quality of our multiple regression line is shown in Table 6, resulting in a coefficient of determination R of 0.746.

Table 5 Coefficients for multiple regression of ROCE

Step	Non standardized coefficients		Standardized coefficients		
	Regression coefficient B	Standard error	Beta	T	Significance
1. Absolute term	−.003	.001		−3.299	.001
Average_Operating_ Margin_Growth	.432	.050	.670	8.651	.000
2. Absolute term	−.003	.001		−4.433	.000
Average_Operating_ Margin_Growth	.383	.048	.593	7.984	.000
Average_Fixed_Asset_ Turnover_Growth	.025	.006	.296	3.984	.000
3. Absolute term	−.004	.001		−5.032	.000
Average_Operating_ Margin_Growth	.312	.056	.484	5.583	.000
Average_Fixed_Asset_ Turnover_Growth	.019	.007	.227	2.881	.005
Average_Revenue_Growth	.028	.012	.217	2.311	.023

Table 6 Model fit of multiple regression of ROCE

Model	R	R^2	Adjusted R^2	Standard errors
1	.670	.449	.443	.006999
2	.728	.530	.520	.006493
3	.746	.557	.542	.006344

The standardized coefficients of Table 5 reveal that value driver OPM shows the strongest leverage on the ROCE metric, while the impacts of value drivers Asset Turnover and Revenue Growth are comparatively weaker. Finally, variable C2C-cycle shows no significant link with ROCE.

6 Conclusions

The quest for value has attracted substantial interest among researchers and managers over the last decades. The study follows the widely accepted principle that economic value is only being created if the profitability (e.g. ROCE) of a company exceeds its cost of capital. Thus profitability and its drivers are keys in value creation.

First of all, the paper presents an overview of other studies' key findings relevant to this study and provides a framework for categorizing the extensive body of literature (see Fig. 2). The literature review reveals a lack of current empirical evidence about the leverage that value drivers actually provide on Return of Capital Employed (ROCE) and it also reveals a lack of empirical data about the linkage among value drivers.

Secondly, this paper illustrates that profitability metrics are superior to metrics that focus on the income statement or balance sheet and do not account for the trade-offs between the two. At the same time the paper elaborates the pitfalls in measuring and interpreting profitability due to the shortcomings of profitability metrics and the existing variety of different metrics (see Fig. 7). Thus, the study does not compare its findings on the long-term evolution of ROCE with existing studies.

Thirdly, the paper provides a meaningful ROCE model for measuring and managing the profitability of the operational business in a value chain. The definition ensures consistency between the numerator and the denominator and links the components of ROCE to four value drivers that can be easily understood and directly controlled by managers across the value chain. This allows a greater value to be extracted from value chain initiatives. The value driver model allows the analysis of trade-offs between lower inventory and a higher utilization of manufacturing equipment. The paper also demonstrates an example of how income statement and balance sheet are selected from the AMADEUS database to determine ROCE and the four value drivers.

Fourthly, the empirical study of 23,489 European manufacturing companies answers five research questions. The most important findings and practical implications are:

- RQ1 and RQ2: By answering if European manufacturing companies can manage profitable growth (RQ1) and if differences in ROCE can be observed between different sectors (RQ2) the following observations have been established: The companies included in the sample show a steady revenue-growth on the median level during the observed period. This growth is characterized by an annual growth rate of 6.1% from 2000 to 2008. Despite this growth, the analysed companies were unable to increase ROCE simultaneously. The median ROCE decreased from 10.8% in 2000 by 2.7 base points to 8.1% in 2008. Note that there are significant distinctions in ROCE according to company size, industry and region. For example, profitability of the large and mid-size companies was significantly higher than the profitability of the smaller companies. This is remarkable. Larger companies are significantly more profitable than smaller companies, while revenue growth does not drive profitability significantly. This seems to be a contradiction and further research needs to be conducted.
- RQ3: The analysis of the effective use of the chosen value driver on median data level shows in first place a low profit margin without a significant trend. It decreased from 4.7% in 2000 to 4.0% in 2008. In 2007 (the year before the economic crises), the median Operating Profit Margin was equal to that at starting point 2000. This clearly indicates that similar to revenue growth, companies' total costs have increased to the same extent. European manufacturing companies may find it difficult to lower prices in order to capture market share. Fixed Asset Turnover increased from 6.1 in 2000 to 6.3 in 2008. Excluding the effects of a change in Italian accounting principles regarding assets in 2008 we can observe an even increased annual growth of 0.11. The

analysis of the C2C-cycle time resulted in no sustainable improvements. The median level of C2C-cycle grew for the entire sample, from 77.1 days in 2000 to 83.2 days in 2008. We assume that management practices, such as off-shoring lead to longer supply chains and the steady increase of DSI from 46.4 days in 2000 to 48.4 days in 2008. However the breakdown of the C2C-cycle time illustrates that inventory at the median level is fully financed by suppliers. Hence inventory does not cause cost of capital. At the same time DSO remains above 80 days and provides an attractive leverage.

- RQ4: Our research shows a significant positive correlation between Revenue Growth and Operating Profit Margin, between Revenue Growth and Fixed Asset Turnover and between Fixed Asset Turnover and Operating Profit Margin. This is a further indication that an isolated focus on top-line growth does not create value and finally it indicates that management decisions have multiple consequences affecting more than one value driver simultaneously.
- RQ5: The study shows a significant impact of Operating Profit Margin, Fixed Asset Turnover and Revenue Growth on ROCE, of which Operating Profit Margin provides the strongest impact. Thus cost effectiveness seems to remain the most important driver of profitability.

The study illustrates the difficulty of being profitable and creating economic value. Top managers should be realistic and should not raise expectations too high. The identified correlation between the value drivers recommends managing all four value drivers simultaneously. In particular top-line initiatives cannot improve profitability if the associated impact on the other value drivers is being ignored.

We conducted a comprehensive study but several important findings still remain to be analysed. Thus, we recommend the following areas for further research:

- Deeper analysis of the impact value chain initiatives on the proposed value drivers (see Fig. 1).
- In-depth investigation of the empirical performance of companies. E.g. further clustering of manufacturing companies into high, moderate and low performer or into different countries and conducting similar investigation of the resulting data regarding trends and correlations. Time-series-analysis can be used as an additional empirical method to derive further research results.
- Analysis of the impact of accounting decisions on ROCE.
- Comparison of our results with the performance companies from the U.S. and Asia.

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When Do Direct Mailings Create Value for Companies? Implications of an Experimental Study in Consumer Goods Markets

Harald Kindermann, Thomas Werani, and Angela Smejkal

Abstract Apart from acquiring new customers, instruments of direct communication also aim at intensive customer service to increase the loyalty of existing customers. In this context, an important question arises: under what conditions can direct mailings generate value for companies? By means of experimental research, the present paper wants to gain knowledge about the changes in customer attitude and loyalty when direct mailing is applied in the context of contractual continuing obligations in consumer goods markets. The findings shall allow an answer to the question, under what conditions direct mailings can create values for companies. It has, for example, turned out that knowing the customers' attitudes is a key factor when applying direct mailings insofar as it influences their content design and objectives, and thus the company's potential value enhancement decisively. Moreover, it has also become manifest that even with direct customer approach, wastage with regard to contents can occur, challenging the application of direct mailings from a value creation point of view.

Keywords Direct communication • Direct marketing • Dissonance theory • Rationalism

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_8, © Springer-Verlag Berlin Heidelberg 2012

1 Introduction

Markets and competition are subject to continuous change, making customer relationship management and, as a consequence, direct marketing, ever more important (Wirtz 2009). It is assumed that instruments of direct customer approach, such as mailings, brochures, folders, and catalogues, provide important opportunities of customer acquisition and enhancing customer loyalty (Lis 2008). This is also reflected by the fact that in Germany in 2007 €11.5 billion were spent on fully addressed advertising mail (Holland 2009).

Continuous developments in the information and communication technology, increasing cost awareness in the application of marketing tools, and an increase in customers changing suppliers regularly are additional essential impulses to promote individual customer approach (Wirtz 2009). Due to manifold information opportunities and the consumers' value change it is in particular customer behaviour that has become more individualised in recent years (Holland et al. 2001), making approaching each individual customer and therefore direct communication more important (Wirtz 2009). Although most companies apply diverse tools of direct marketing, a big share of their budget is spent on addressed advertising material (Lis 2008).

Marketing departments are steadily expanding their scope of direct marketing activities due to improved framework conditions, provided, for example, by the Internet with its full range of opportunities. In addition, companies are increasing the number of direct advertising mail sent to every individual consumer. The resulting message flood first results in a growing indifference to the provided information and second to an increasing rejection of the involved media. As a consequence, more research has been started to critically deal with the activities and instruments of direct marking in practice (Ebersbach 2008). In this context, yet another question arises: under what conditions can direct mailings generate value for companies? If we define value by the ratio between applied means (costs) and resulting benefit, the economic principle prefers from all relevant alternatives in a specific situation the one that reaches the highest quotient of benefit and costs, having at least the value 1 (Werani 1998; Mühleder 1996). If a company is to decide on the application of direct mailings, it will only apply this instrument if the resulting benefit can at least cover the costs.

By means of experimental research, the present paper wants to gain knowledge about the changes in customer attitude and loyalty when direct mailing is applied in the context of contractual continuing obligations in consumer goods markets. The findings shall allow an answer to the question, under what conditions direct mailings can create value for companies.

2 Conceptual and Theoretical Principles

2.1 Direct Marketing – Conceptual Outline

The definitions of direct marketing are manifold (Löffler and Scherfke 2000), and many meanings have been attributed to it over time (Kotler et al. 2007). As a consequence, the concept of direct marketing has steadily developed in line with the possible characteristics and fields of application of direct marketing measures. Originally characterised by manufacturers selling goods or services to consumers without marketing intermediaries, the later meaning of the word "direct" as an expression of this manufacturer-consumer-relation did not apply any more, since this type of sales activities (via manufacturer or retailer) had lost significance (Kotler et al. 2007). Löffler and Scherfke (2000) start their definition with various scientific approaches and eventually come to the summarised conclusion that "the essential element of direct marketing is a target-oriented communication process with known addressees, based on a database. Direct marketing uses one or several media and permits a response from the customer".

According to Kotler et al. (2007) the development and application of electronic media has influenced the Direct Marketing Association to come to the following definition: "Direct marketing is an interactive system of marketing which uses one or more advertising media to effect a measurable response and/or transaction at any location".

However, direct marketing is often considered more comprehensively these days – as direct relationship marketing. This means that not only the acquisition of an inquiry or order is the main aim of activities but establishing a long-lasting and valuable relationship with the customer plays a vital role, too (Kotler et al. 2007).

These outlined development steps made direct marketing become an approach that embraces data acquisition and storage of information about the customer that is relevant under purchasing and behavioural aspects, including the analysis of the performance of diverse tools to maximise the return on investment (Harridge-March 2008).

2.2 The Role of Direct Mailing in Direct Marketing

A mailing is a means of advertising that can be physically experienced by consumers and shall therefore be designed accordingly. It often consists of the components envelope, letter, brochure and response element (Holland 2009). All components are to be designed in a target-oriented way. In this respect, there are no limits to creativity (Löffler and Scherfke 2000). The objectives of this medium start with the sale of goods or services, and extend to the search for prospective buyers or to rewarding loyal customers (Kotler et al. 2007). Moreover, this form of advertising has the advantage that the consumer gives at least a minimum of attention to the conveyed message – if it is opened and perceived (Löffler and Scherfke 2000).

Direct mailing has a key function within direct marketing (Wirtz 2009; Faulkner and Kennedy 2008; Thomas and Housden 2002). According to a survey carried out by the German Mail Service (Deutsche Post AG) in 2007 €11.5 billion were spent on fully addressed advertising mail in direct marketing (Holland 2009). This is an interesting fact insofar as due to the developments in information and communication technology, companies have a great diversity of other media at their disposal. Nonetheless, direct mailing is of great significance when compared to other direct marketing media. To put this figure into perspective, in 2007, €4.7 billion were spent on active and passive telephone marketing, €1.7 billion on e-mail marketing and €5.1 billion on Internet marketing (Holland 2009). Although marketing departments are taking the application of new technologies in direct marketing into consideration to reach a broad mass of people in a cost-efficient way, traditional direct mailing remains an important tool to approach customers (Morimoto and Chang 2006).

Addressed advertising mail has the characteristic that on the basis of available (purchased or existing) customer data it is sent to a determined circle of customers or potential customers. The spectrum is wide: starting with the classic advertising letter, extending to a package comprising catalogues, test samples or other attachments (Löffler and Scherfke 2000). Partly addressed or unaddressed mailings are, however, standardised messages that are distributed through bulk mail or a general distributor (Wirtz 2009). Therefore, these are not considered direct advertising media.

The decision whether a mailing is opened or read by a recipient depends on external influences (place and time, technical or climatic factors), social influences (presence of other persons when the mailing is received) and the design of the mailing. The latter factor has the greatest influence on the success of a mailing, since it determines its attractiveness (Holland 2009).

In the empirical part of this paper, explicitly the design of mailings will be relevant due to its central significance. In contrast to the other factors listed above, design can also be measured without any problems.

2.3 Direct Marketing and Customer Retention – An Approach of Dissonance Theory

Apart from acquiring customers, sales and communication, direct marketing also aims at customer retention (Holland 2009) and thus plays an important role in successful strategy implementation in this respect (Lara and Ponzoa 2008). The concept of customer retention can be differentiated by following a measure- and behaviour-oriented approach (Werani 2004).

The measure-oriented approach regards customer retention as a bundle of activities that seem appropriate for making business relations closer to prevent customers from changing over to competitors (Diller 1996; Werani 2004). These retention measures can result in loyalty (= voluntary, based on satisfaction) and dependency (= mostly involuntary, based on a perceived restriction of the customer's freedom of choice) (Weinberg and Terlutter 2003; Eggert 1999). The applied measures influence customer behaviour and are reflected in their purchasing pattern (Werani 2004; Diller 1996). The behaviour-oriented approach focuses on the repurchasing pattern of customers. From this perspective, customer loyalty is "the result that shall be achieved through measures of offering goods and services to the customer" (Krüger-Strohmayer 2000).

In the present paper, both the measure and behaviour-oriented approach are relevant. While the first approach relates to the application of direct mailings in our experiment, the second plays a role insofar as it is another objective of our experiment to analyse the effect of direct mailings on customer loyalty.

The central benefit of enhanced customer retention is that acquisition costs are saved, since the acquisition of new customers is significantly more expensive than retaining an existing customer. Moreover, reducing customer defections by 5% can result in an increase of revenues by up to 85% (Holland 2009). In order to conduct targeted customer retention management, it is inevitable to deal with how customer loyalty establishes. In this context, the present paper draws on an approach of Dissonance Theory for explication.

The basic concepts of Festinger's Theory of Cognitive Dissonance (Festinger 1957) comprise cognitive elements or cognitions and their relation among each other. Its fundamental assumption is that individuals want to optimise their well-being and aspire to a positive self-concept. If their actual perception or behaviour deviates from this positive self-concept a feeling of uncomfortableness will arise. However, according to Festinger, people seek consistent relations between individual cognitions (cf. also Spangenberg et al. 2003; Frey and Benning 1997), though he does not define the cognitive elements in more detail in his theory but describes them as thoughts, beliefs, opinions and attitudes.

Cognitions can be in a relevant or irrelevant relationship to each other. A relevant relationship is given if the cognitions are related. An irrelevant relationship is given if certain cognitions at a certain time are not related in the individual's perception. The relevant relationships are of special interest, being subdivided into consonant and dissonant relationships. In a consonant relationship the cognitive elements match and harmonise. A dissonant relationship means, though, that the cognitive elements do not harmonise and contradict each other (Herkner 2001).

As soon as dissonant relationships have emerged, an uncomfortable, tense condition arises, the so-called "cognitive dissonance". This condition has an instinctive character because it leads to processes or generates a motivation that shall reduce or eliminate this dissonance (Herkner 2001).

As soon as a person feels a dissonance, for example, because he or she has to act against his or her own attitude (behaviour with a negative valence) and finds no sufficient external justification for this behaviour, processes are triggered in this person that shall balance the action-related dissonance. To this end, this person has three general options (Rühl 2008; Chiou 2008; Aronson et al. 2004; Herkner 2001):

(a) The person stops dealing with the cognitions that have caused the dissonance by stopping to think about the negative aspects. The person avoids dealing with the problem and ignores the negative associated circumstances. This strategy of actively ignoring dissonant cognitions reduces their relevance. Recent findings have shown that suppressing undesired knowledge representations actually results in a fade-out of the remembrance performance with regard to these cognitions (Squire and Kandel 2009).
(b) The person must modify the cognitive elements in a way that dissonant relationships become consonant.
(c) The person absorbs new cognitive elements in a way that consonant relationships are established between already existing and new elements.

What is important is that the latter case does not mean a change of opinion based on new information but rather a mostly unaware change of opinion caused by a strong dissonance. “These are rationalisations (unrealistic justifications of own points of view and behavioural patterns)” (Herkner 2001).

Applying the findings of the Theory of Cognitive Dissonance to the field of customer retention, the customer will avoid gathering information in his or her business relation that will increase dissonances after a purchase and rather look for information that will decrease dissonances (Bagusat 2006). Direct mailings actually provide information that is personally sent to a customer and thus result in an opportunity of direct marketing to convey messages to the customer that shall reduce dissonances. Thus it becomes possible to upvalue the customer’s attitude towards the supplier, trigger repurchases and establish a long-term business relationship. After several purchases the probability of cognitive dissonances will decrease and make way for a perceived psychological balance and thus will promote customer loyalty (Bagusat 2006).

It shall be noted that if customer retention is based on contractual continuing obligations, the issue of dissonance reduction becomes even more significant than in a non-contractual relationship. Since in the latter case, apart from dissonance reduction also dissonance avoidance through terminating the relationship can provide an option to regain one’s psychological balance, in contractual relationships this balance can usually only be generated through accordingly intensive strategies of dissonance reduction. In this light, direct mailings reducing dissonances shall be qualified as especially important in relationships of contractual continuing obligations.

3 Research Hypotheses

Basically, every human being endeavours to behave in accordance with his or her self-concept (Aronson et al. 2004). He or she constantly reflects his or her environment and tries to establish possibly consistent relationships between perceived impressions and earlier experiences. As soon as a person recognises a contradiction, this situation causes tension – the cognitive dissonance – and a motivation to return to a consonant state (Frey 1997). Earlier experiences are nothing else than mental structures that have been stored in the memory as semantic networks. They can also be called schemata (Anderson 2007). An important characteristic of schemata is that they possess default values enabling people to draw possibly consistent conclusions (Anderson 2007; Aronson et al. 2004). Hence, in the context of this paper, it can be concluded that the stimulus of direct mailing is evaluated (by the customer) in particular on the basis of already existing schemata – embracing thoughts, beliefs, opinions and attitudes. Therefore it can be expected that customers with a generally positive attitude towards a company will evaluate direct mailings more positively than customers with a generally negative attitude.

Hypothesis 1: customers with an originally positive attitude evaluate direct mailings better than customers with an originally negative attitude.

From the core message of the Theory of Cognitive Dissonance – that persons who feel an inner tension are willing to eliminate or to reduce this dissonance – can be concluded that for the present investigation in particular those persons are of vital interest that already have had a negative attitude towards a company with which they have had an active business relation *before* receiving a sales promotion measure by mail. This is because these persons present cognitive dissonances due to the negatively evaluated business relation. As long as the customer cannot terminate the relationship, as it is the case with contractual continuing obligations, which are dealt with in this paper, the customer will try to change his or her dissonant status towards a consonant situation. He or she will resort to rationalisations and seek arguments in favour of a continuation of the business relationship to reduce the existing dissonance. Ultimately, it can be assumed that even without direct mailings, attitude and customer loyalty will improve due to the rationalisation effect.

Hypothesis 2 – Rationalisation Effect:
Hypothesis 2a: the attitude of customers with an originally negative attitude will improve irrespective of direct mailings.
Hypothesis 2b: the loyalty of customers with an originally negative attitude will improve irrespective of direct mailings.

We have already indicated that the design of a direct mailing influences its success most. Therefore it can be assumed that apart from the rationalisation effect, liking or not liking a mailing has an impact on customer attitude and loyalty, which leads to the following hypotheses:

Hypothesis 3a: if customers with an originally negative attitude like a mailing, this influences their attitude in a positive way.
Hypothesis 3b: if customers with an originally negative attitude like a mailing, this influences their customer loyalty in a positive way.
Hypothesis 4a: if customers with an originally negative attitude do not like a mailing, this influences their attitude in a negative way.

Hypothesis 4b: if customers with an originally negative attitude do not like a mailing, this influences their customer loyalty in a negative way.

4 Methodology

4.1 Experimental Design and Data Basis

For our customer retention experiment, 7,200 randomly selected private customers of mobilkom Austria AG (telecommunications), UNIQA AG (insurance), Verbund Power Sales GmbH (energy) and Volkskreditbank AG (bank) were available. In all cases, there was a contractual continuing obligation between the customer and the respective company. The survey was designed as an experiment to gather findings about the alteration of attitudes and customer loyalty under the influence of direct mailings.

The survey consists of a pre-test and post-test. The pre-test served for verifying the status of attitude and customer loyalty before direct mailings were applied. The post-test was carried out after application and sending direct mailings to the customers and enabled us to draw conclusions on the effects of this instrument on the two mentioned constructs.

Interviews were carried out by means of a standardised questionnaire. The survey took place from spring 2007 (recording the current situation = pre-test) until spring 2008 (investigation after sending direct mailings = post-test).

Of each company, 1,800 customers were randomly selected from the total quantity of customers and interviewed by telephone for the pre-test and post-test.

Before direct mailings were sent, each company data record was subdivided into four groups, each with 450 customers – one control group and three experimental groups. The control group did not receive any advertising mail while the experimental groups received the, in Table 1, described addressed mailings. Splitting the experimental groups into three was done to guarantee the accuracy of the experiment by taking into account diverse direct mailing alternatives. In order to keep the data of the involved companies comparable, the same direct mailing measures were taken for each individual experimental group.

Table 1 Direct mailings of experimental group 1

Mailing	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Date	November 2007	December 2007	February 2008	March 2008	April 2008	May 2008
Topic	Advent	New Year's Eve	St. Valentine's Day	Spring	Luck	Summer
Attachment	Advent calendar	No attachment	Flower seeds	Spring tea	Break-open instant win ticket	Beach check

Experimental Group 1

The randomly selected 4 × 450 customers received six different letters with diverse attachments; the letters being printed on the respective company's letter-head. The attachments were always related to the contents of the letter (for example "Advent" had the attachment "Advent calendar"). Table 1 provides an overview of the six mailings.

Experimental Group 2

In November 2007 (with a reminder in January 2008), another 4 × 450 randomly selected customers received the offer that if they joined the Shell-Club-Smart they would receive the triple of the usual bonus. Usual bonus means that Shell-Club-Smart customers get a bonus point for every filled-up litre of fuel. With the collected bonus points customers can purchase diverse products in Shell shops cheaper.

Experimental Group 3

To this group (4 × 450 randomly selected customers), five mailings containing vouchers with diverse shopping benefits were sent (see Table 2).

In the course of the post-test those customers were addressed that had also been interviewed during the recording of the current situation (pre-test). However, the

Table 2 Direct mailings of experimental group 3

Mailing	No. 1	No. 2	No. 3	No. 4	No. 5
Date	December 2007	January 2008	March 2008	April 2008	May 2008
Voucher for hardware store	Discount of 10%	Discount of 10%	Discount of 10%	Discount of 10%	Discount of 10%
Voucher for sports shop	€20 discount	Discount on carving skis	Discount on Nike backpack	Discount on Nike trainers	Billabong T-shirt
Vouchers for mail order	No voucher	20% discount on textiles	20% discount on clothes	30% discount on favourite article	20% discount on children's clothes
Voucher for cinema	No voucher	€7 (Bollywood and Lord of the Rings)	No voucher	No voucher	No voucher

random sample was reduced because not all contact persons could be reached again, and some of them refused being interviewed. Only a fraction of the contact persons could not be reached any more because their contract relationship at the time of the post-test had already ceased (0.3% of the persons of the pre-test), which could be verified with the respective companies' customer database. Figure 1 shows an overview of the design and data basis of the carried-out experiment.

4.2 Construct Measurement

In order to test the formulated hypotheses, it was necessary to operationalize the constructs of attitude, customer loyalty and appreciation of the mailings. Table 3 shows the indicators and scales that were applied to measure the respective constructs.

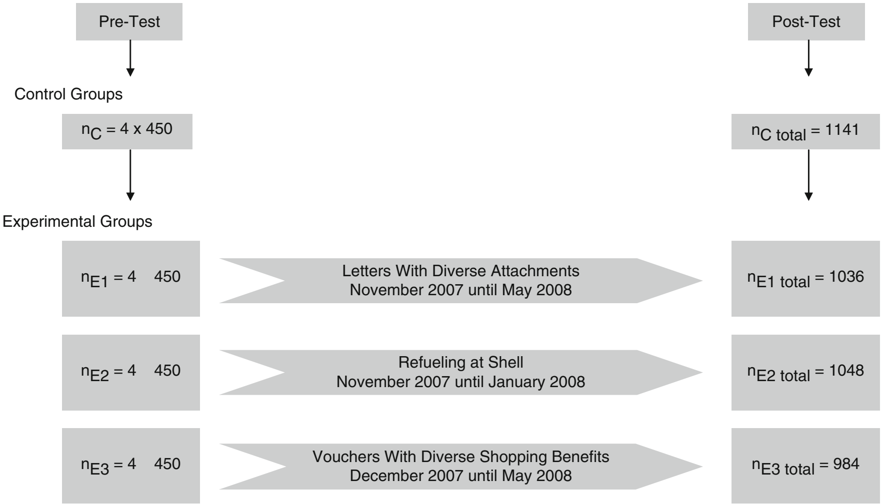

Fig. 1 Design and data basis of the experiment

Table 3 Construct operationalization

Construct	Indicators and scales
Attitude	[Company] mainly matches my expectations.
	I have a positive attitude towards [the company].
	Retrospectively, it was a good decision to opt for [company].
	Five-grade scale from 1 = fully agree to 5 = do not agree at all
Customer Loyalty	I am currently looking for a different supplier.
	I have been thinking about changing my supplier for some time.
	I will change supplier within the next months.
	Five-grade scale from 1 = fully agree to 5 = do not agree at all
Appreciation of Mailings	How did you like the letters?
	Five-grade scale from 1 = liked very much to 5 = did not like at all

Table 4 Psychometric properties of the scales (basis: all interviewees)

Construct	Mean	Standard deviation	Cronbach's alpha	Construct reliability	Average variance extracted
Pre-test					
Attitude	1.61	0.78	0.84	0.90	0.75
Customer loyalty	4.54	0.87	0.77	0.87	0.69
Post-test					
Attitude	1.61	0.77	0.83	0.90	0.74
Customer loyalty	4.55	0.85	0.77	0.87	0.69

While it was verified via one indicator only whether a mailing was liked or not, the constructs of attitude and customer loyalty were based on several indicators. Table 4 shows the psychometric properties of the developed scales for the latter constructs. Cronbach's alpha, construct reliability and the average variance extracted indicate sufficient reliability and convergence validity of all scales. All alpha values are beyond 0.70, all construct reliabilities over 0.60 and all average variances extracted over 0.50, thus reaching and even exceeding usual threshold values (Bagozzi 1994; Bagozzi and Yi 1988; Fornell and Larcker 1981).

5 Survey Results

With regard to hypothesis 1 the one-sample *t*-test for independent samples has shown that those persons that originally had a positive attitude towards the company (that is, persons whose attitude was 1 or 2 on the five-grade scale) liked the mailings significantly more ($t = -2.227$; $df = 845$; $p = 0.013$) (mean: 2.71; standard deviation: 1.23; $n = 836$) than those customers that originally had a negative attitude (mean: 3.55; standard deviation: 1.39; $n = 11$). "Negative attitude" defines those customers that had graded their attitude with 4 or 5. This makes evident that the evaluation of mailings depends on the customer's original attitude towards the company, which confirms hypothesis 1. Since hypothesis 1 is formulated as a difference hypothesis, customers with a neutral attitude are not taken into account, which could distort the results of the hypothesis test. Therefore, the following relationship hypothesis is formulated as a supplement on the basis of all interviewees who had taken notice of the mailings ($n = 985$):

Hypothesis 1a: the more positive the customer's original attitude, the better are the direct mailings evaluated.

For the regression-analytically identified β-coefficient, a value of 0.16 was found, which is quite significant ($t = 5.102$; $p = 0.00$). This confirms the result of the test of hypothesis 1 even if the customers with neutral attitudes are included.

In order to verify the rationalisation effect irrespective of the application of direct mailings (hypothesis 2a and 2b), those customers were considered in the sample that originally had a negative attitude ($n = 76$). Of these 76, only those are relevant that (a) had no contact with the direct mailings, that is, members of the control group ($n = 29$), or (b) those that had not perceived the sent direct mailings ($n = 36$). It shall be noted that for the test of all following hypotheses, Wilcoxon tests for dependent samples are applied if the sample size is small. For large sample sizes, parametric t-tests are applied.

The mean of the attitude of the control groups ($n = 29$) changed from 4.48 before the mailing to 2.91 ($Z = -3.883$; $p = 0.00$) afterwards, and the mean of customer loyalty from 2.85 before to 3.78 after the mailings ($Z = -2.75$; $p = 0.003$), pointing significantly in the expected direction.

With participants of the experimental groups who had not perceived the mailing ($n = 36$), the mean of the attitude changed from originally 4.45 to 2.40 ($Z = -5.028$; $p = 0.00$) and the mean of customer loyalty from 2.81 to 3.93 ($Z = -3.752$; $p = 0.00$) – again pointing significantly in the postulated direction.

The hypotheses tests have shown that the rationalisation effect has occurred both in the control groups and among the relevant participants of the experimental groups, explaining why customer attitude and loyalty has improved over time without having received or perceived direct mailings. In order to make sure that the postulated improvement of customer attitude and loyalty can be related only to the rationalisation effect and not also to a general trend during the period of investigation, also the customers with originally neutral and positive attitudes were analysed. If also in this group an improved attitude and customer loyalty was shown (what by definition could only be explained by a general trend and not by the rationalisation effect) this would imply that the same trend would be effective also with the customers with originally negative attitudes, which would render the rationalisation effect questionable. Of the customers with originally neutral and positive attitudes ($n = 4{,}133$), only those persons are relevant in line with the verification of the hypotheses 2a and 2b who (a) did not get in touch with the direct mailings, that is, members of the control groups ($n = 1{,}112$), or (b) did not perceive the received direct mailings ($n = 2{,}047$).

The mean of the attitude of the control groups ($n = 1{,}112$) changed from 1.56 before the mailings to 1.57 afterwards ($t = -0.401$; $df = 1{,}111$; $p = 0.344$) and the customer loyalty value from 4.56 before the mailings to 4.53 afterwards ($t = 0.863$; $df = 1{,}111$; $p = 0.194$) – showing no significant change in customer attitude and loyalty.

With the members of the experimental groups who had not perceived the direct mailings ($n = 2{,}047$) the attitude value changed from originally 1.58–1.63 ($t = -3.245$; $df = 2{,}046$; $p = 0.00$) and the customer loyalty value from 4.58 to 4.51 ($t = 3.119$; $df = 2{,}046$; $p = 0.001$). In the experimental groups, attitude and customer loyalty have deteriorated significantly.

The additional analyses have shown that there is no general trend in the improvement of customer attitude and loyalty during the investigation period.

The hypotheses 2a and 2b – and hence the rationalisation effect – can therefore be absolutely confirmed.

For the hypotheses 3a through 4b all those test persons were investigated that originally had a negative attitude and had perceived the mailings ($n = 11$). Six persons who liked the mailings (persons who evaluated the mailings on the five-grade scale with 1 or 2) form the basis for the hypotheses 3a and 3b, while five persons who did not like the mailings (grade 4 or 5) were taken for the hypotheses 4a and 4b.

Those test persons that originally had a negative attitude but liked the mailings ($n = 6$) improved their attitude significantly (mean before = 4.56; mean afterwards = 2.28; $Z = -2.023$; $p = 0.022$). Also customer loyalty improved significantly (mean before = 2.78; mean afterwards = 4.50; $Z = -1.753$; $p = 0.040$). The hypotheses 3a and 3b can therefore be confirmed.

The test persons with originally negative attitudes who did not like the mailings ($n = 5$) changed their attitude against expectations in a positive direction (mean before = 4.40; mean afterwards = 4.07), though not significantly ($Z = -1.289$; $p = 0.098$). The customer loyalty value deteriorated as postulated (mean before = 3.33; mean afterwards = 2.27), though not significantly either ($Z = -1.069$; $p = 0.142$). The hypotheses 4a and 4b can thus not be confirmed.

The results of the statistic tests allow the conclusions that direct mailings have additional effects that – when the mailings are liked – significantly improve attitude and customer loyalty. However, to establish a relation between this direct effect of the mailings and the rationalisation effect, the descriptive survey results must be contemplated. If we compare the mean value differences of the group with originally negative attitude who had perceived and liked the mailings (that is, persons whom both the immediate mailing and rationalisation effect could influence) to the mean value differences of the two groups used to confirm the rationalisation effect (did not get in touch with the mailings or did not perceive them), it turns out that the differences in the first group are higher (see Table 5). From this it can be concluded that if their attitude was originally negative, a positive perception of the mailings together with the rationalisation effect has an additional positive influence on customer attitude and loyalty.

Not liking the mailings in case of originally negative attitude has no significant influence on customer attitude and loyalty as far as statistics are concerned. On the descriptive level, however, a marginal improvement of attitude and deterioration of

Table 5 Mean value differences in attitude and customer loyalty of persons with originally negative attitudes

Group	Not exposed to mailings ($n = 29$)	Not perceived mailings ($n = 36$)	Liked the mailings ($n = 6$)	Not liked the mailings ($n = 5$)
Mean value difference in attitude	−1.57	−2.05	−2.28	−0.33
Mean value difference in customer loyalty	0.93	1.12	1.72	−1.06

customer loyalty is shown (Table 5/last column). Since on the basis of the present results the additionally occurring rationalisation effect in case of originally negative attitude results in a significant improvement of attitude and customer loyalty (Table 5/second and third column), we can draw the conclusion that not liking the mailings could reduce or even overcompensate for the rationalisation effect.

Those persons that originally had a positive attitude towards the company (n = 836) already presented a high degree of customer loyalty (mean: 4.75) even before the experiment measures were taken. This shows that in this group the potential to improve customer loyalty through direct mailings is very low.

6 Implications for Business Practice

The results of the experimental study have shown in particular that

- Customers with an originally positive attitude like direct mailings significantly better than customers with an originally negative attitude. Hence, the evaluation of the mailings depends on the customers' original attitude.
- With existing customers who originally had a negative attitude towards the company, attitude and customer loyalty improve over time irrespective of direct mailing measures, which can be explained by the rationalisation effect.
- With customers with an originally negative attitude a positive effect on attitude and customer loyalty is achieved (apart from the rationalisation effect), if they like the mailings.
- Not liking the mailings in case of an originally negative attitude can reduce the rationalisation effect that usually improves customer attitude and loyalty, or even overcompensate for it.

From the present empiric findings the following implications for business practice can be derived:

Knowing the Customers' Attitude Is a Key Factor When Direct Mailings Are Applied

The facts that the evaluation of direct mailings is influenced by the customer's original attitude and that a more positive attitude will result in a better evaluation could suggest at first sight to follow effectiveness considerations and approach in particular those persons via direct mailings that tend to have a positive attitude. However, it has shown that in particular these persons already have such a high degree of customer loyalty that direct mailings shall be applied only with the objective to sustainably secure the business relations and not to intensify customer retention. In the latter case it can be assumed that the applied means will be higher than the resulting benefits, making it impossible to generate a positive value for the company. The situation is quite different with regard to customers with originally negative attitudes: in this case direct mailings – given that they are liked – have the potential to improve customer attitude and loyalty, which makes them interesting for companies from a value generation point of view. On the whole it has turned out that knowing the customers' attitudes is a key factor when applying direct mailings insofar as it influences their content design and objectives and hence a company's value generation decisively.

Necessity of an Appealing Design of Direct Mailings

Following the approach of Dissonance Theory, it could be shown that customers with an originally negative attitude improve their attitude and customer loyalty over time irrespective of whether direct mailings are applied, which is caused by the rationalisation effect. Using direct mailings on this customer group can, however, result in further improvement of attitude and loyalty, but only if the customers actually like the mailing. Empiric findings therefore strongly suggest to design these mailings adequately. Even if such design increased costs would such mailings have a significantly higher potential of value generation than a customer acquisition strategy.

Wastage Does Not Equal Wastage

In relevant literature, direct communication is considered to have the advantage of minimising wastage since each relevant customer can be approached in a target-oriented way (Ebersbach 2008; Busch et al. 2008; Holland 2009). The present study results, however, show that wastage can even occur when customers are approached directly, in a content-related way, because with regard to the group of customers with originally negative attitudes it is apparently not enough to just approach them. They must also like the mailings to improve their attitudes and loyalty, thus allowing a company to generate value. If customers do not like the mailings, though, even the rationalisation effect that would normally improve their attitudes and loyalty can be reduced or even overcompensated for, and it would have been better not to have started any direct communication at all from a value generation point of view. As a consequence it seems to be sensible to discuss the issue of wastage in direct communication measures also taking into account content design.

7 Limitations of the Study

First of all, we would like to point out that the survey results are valid only for contractual continuing obligations, due to the selected survey context. In particular the postulated rationalisation effect is a consequence of the contractual situation.

Second, the small sample sizes that were the basis for testing hypotheses 2, 3 and 4, must not be disregarded. Although non-parametric tests were applied to compensate for this situation, gained findings shall be backed up by additional surveys.

Third, in the context of evaluating hypothesis 2 (rationalisation effect), interviewees who had not received any direct mailings (members of the control groups) were put on the same level as persons who had not perceived the received mailings. This could be problematic insofar as missing recollection of the mailings does not necessarily mean that the mailings had no effect at the time they were actually received. This would imply a totally different situation than the one of the control groups. Eventually, this potential limitation does not seem to play a vital role, since the results of the control groups are, without any exception, parallel to those of the experimental group members who had not perceived the mailings.

Finally, it shall be noted for the hypotheses 3 and 4 that the question of whether customers liked the mailings or not was placed sometime after the mailings had been received. Relevant research indicates in this context that a retrospective evaluation can be subject to distortions ("hindsight bias"). It can be assumed that persons who know the outcome of an event will retrospectively assess the situation as if they had known the outcome right away. With regard to customer satisfaction the hindsight bias has the effect that satisfied customers state that they had always been convinced of the quality of the product, while unhappy customers had always known that the product would not satisfy their demands (Werth 2004). In this respect it cannot be excluded with regard to the hypotheses 3 and 4 that the retrospective evaluation of the mailings was influenced by the current status of the relation to the supplier, which can also have reasons other than the mailings. Therefore, the correlation between liking/not linking the mailings and customer attitude or loyalty may not necessarily point in the postulated direction.

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Fair Distribution of Added Values in Networks of Autonomous Actors

Susanne Jene and Stephan Zelewski

Abstract Most scientific publications on the subject of value chain management only analyse which structures, processes and actions can contribute to value creation. How the distribution of added values that were collectively achieved in a network of autonomous actors can influence the stability of such a network is often disregarded. The distributive justice or the fair distribution of collectively created added values is one of the most important ways to secure the stability of networks. This paper therefore presents a proposal for an operationalization of the fairness term from an economic perspective. This proposal is specific to the distribution of cooperation gains in networks of autonomously acting companies and takes a cooperative game theory approach as its basis. With the aid of the τ-value, it is shown how intuitive and vague associations of fairness can be substantiated to give a concrete distribution proposal that can be perceived and communicated as fair by gradually establishing rational or at least plausible assumptions.

Keywords Cooperation gains • Cooperative game theory • Distribution of added values • Fairness • Supply chain management • Supply networks • τ-value

1 Introduction

Value chain management is based on the idea, that, with the aid of goal-oriented management of a cooperation of multiple companies, it is possible to achieve special *cooperation gains* or *added values* that cannot be realized without cooperation. The companies are generally assumed to be legally autonomous entities,

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_9,

whose cooperation does not rely on hierarchical instruction – as is the case between divisions of one company. Here it is rather implied that cooperation is based on voluntary collaboration that is economically beneficial from the perspective of each company involved. Such circumstances arise, for example, in supply chains that strictly speaking are supply webs, innovation or production networks, or virtual cooperations. Such forms of inter-organizational cooperation can generally be described as *networks of autonomous actors*. Because added values are achieved on account of the companies of the actors compared to non-cooperation (defection), such networks are often referred to under the umbrella-term *value chain*.

The *creation of added values* in networks of autonomous actors, or value chains for short, is disputed. Basic theoretical considerations show that central coordination of collaboration based on the division of labour of several actors can never yield worse, and often yield better economic results than the aggregation of many partial plans that are locally "optimized" by each actor. However, total-planning models based on such a central coordination approach fail most of the time on account of unachievable assumptions relating to the availability of current and detailed information.

A large number of theoretical analyses and practical studies show that cooperation gains can be achieved de facto as added values in value chains. This also applies to complex models of multilayer supply chains, which can help to show that the mutual adjustment of the actors with regard to their action plans as a central coordination approach normally yields higher economic values than if the actors optimize their action plans locally and without interaction (cf. Li et al. 2009; Mahdavi et al. 2008; Saharidis et al. 2009; Xiao et al. 2009; Zhang 2006).

Most scientific publications on the subject of value chain management *only* analyse which structures, processes and actions can contribute to the cooperative *creation* of added values. But how the *distribution* of added values that were collectively achieved in a network of autonomous actors can influence the stability of such a network is often *disregarded*.

This widespread neglect of distribution aspects represents a significant *research gap*. The formation and the drifting apart of networks of autonomous actors generally depend on the actors regarding the distribution of hoped for or already realized cooperation gains as fair. Distributive justice, or synonymously, fair distribution of collectively created added values is one of the most important approaches to securing the stability of networks in political, socio-scientific and behaviour-economic publications on the subject of network theory. Analysis of the conditions under which fair distribution of collectively created added values is realized also has very high *relevance* to value chain management. Without the – at least temporary – stability of cooperation in a network of autonomous actors, the added values of a value chain could not be realized in the first place.

This article therefore examines the *scientific problem* of how the cooperation gain can be distributed to the actors as network partners in such a way that all actors regard the *distribution outcome* as *fair*. To solve this problem, *scientific methods* from the area of *game theory* will be applied. Aspects informing the choice of methods are that the networks or value chains considered here consist of legally independent companies (or autonomous actors for short) who each are pursuing their own interests and do not have to comply with the instructions of their cooperation partners. An analysis is additionally made from the perspective of *cooperative* game theory, since it is also a matter of securing the stability of the companies' cooperation by way of a perceived fair distribution of collectively achieved added values as cooperation gains.

The *relevant literature* includes multiple contributions that draw on cooperative game theory to try and answer the problem of how added values that were collectively achieved in a network of autonomous actors can be distributed among the network partners in a fair way. Examples include the analyses of Cachon and Zipkin (1999); Fromen (2004); Gjerdrum et al. (2001); Inderfurth and Minner (2001); Minner (2007); Sucky (2004a, b, 2005); Thun (2005); Voß and Schneidereit (2002). These contributions all share common ground in that they only cover the scientific and practical problem of *fairness* of cooperation gain distributions superficially. Usually, a solution concept from cooperative game theory is used, whose fairness or acceptability is implied, but not closely reflected. This applies above all for the application of the Shapley value (cf. Thun 2005; Voß and Schneidereit 2002), the nucleolus (e.g. Fromen 2004; Voß and Schneidereit 2002) as well as the cooperative Nash solution (e.g. Sucky 2004a, b, 2005). Only Fromen (2004) discusses a wide selection of different solution concepts of cooperative game theory. He examines them mostly from a mathematical and analytical perspective, but not from the pragmatic viewpoint of their acceptability as fair solution concepts. For a detailed discussion of the current situation outlined above, see Zelewski (2009, pp. 30–34).

The present article discusses an *innovative approach* to fair distribution outcomes. It rejects the assumption of a solution concept from cooperative game theory as "a given" and its application to a distribution problem of added value while "naively" assuming that the resulting distribution outcome will be accepted as fair. Instead, it limits the space of generally possible distribution outcomes by making assumptions regarding the rationality of the actors and the measurement of their contributions to a network of autonomous actors. If all these assumptions are accepted as "plausible" or "reasonable," the result is a specific solution concept from cooperative game theory rarely found in the economic literature, the so-called τ-value. The *fairness* of the τ-value and the associated distribution outcomes is *justified* by the acceptability of the gradually established assumptions regarding the "plausible" or "reasonable" limitation of the valid solution space. These assumptions cannot be equated with the formalistic axioms of conventional game theory, as will be shown in the following. It is not a matter of abstract, artificial mathematical characteristics, but of intuitively understandable and, from an economic perspective, strong assumptions to a game theory concept designed to solve the above mentioned scientific – but also practical – problem of fair distribution of added values or cooperation gains in networks of autonomous actors.

The *structure of this paper* is as follows: the first part employs a constructive-synthetic inquiry design. A formal language model is constructed that represents the distribution of added values in networks of autonomous actors as a cooperative distribution game. Within this model, the scope of possible added value distributions is gradually limited by multiple assumptions of individual and collective rationality, and of efficiency and integrity. The τ-value finally results in an operational and unique game theory guideline for fair distributions. The second part of this paper is based on a model-analytical inquiry design. With the help of the aforementioned cooperative distribution game model, some characteristic properties of the τ-value are analysed. These properties firstly characterize the τ-value as a typical compromise solution concept with some remarkable aspects. Secondly, a new interpretation of the τ-value is presented from the perspective of the actors' network contributions. Thirdly, some controversial assumptions regarding the τ-value are discussed.

2 The $\boldsymbol{\tau}$-Value as a Solution to the Problem of Fair Added Value Distributions in Supply Chain Management

2.1 A Cooperative Distribution Game

The starting point for the cooperative distribution game is the *generic distribution problem* of distributing an added value or, synonymously, a cooperation gain G with $G \in \mathbb{R}_{>0}$ (where $\mathbb{R}_{>0}$ is the set of all positive real numbers) among the N autonomous actors A_n of a value chain (with $n = 1,\ldots, N$, $N \in \mathbb{N}$ and $N \geq 2$, where $\mathbb{N}$ is the set of all natural numbers). The standard approach of cooperative game theory to solving this generic distribution problem comprises two steps.

In the first step, a characteristic function c is developed. This function refers to all possible coalitions which could be formed by the actors in the relevant value chain. Moreover, "degenerate" coalitions formed by one actor are feasible. Therefore, a coalition C_m is a non-empty subset of the set A of all actors in the value chain: $\emptyset \subset C_m \subseteq A$ with $A = \{A_1,\ldots, A_N\}$. For each characteristic function c, it is assumed with $\wp$ as power set operator that c: $\wp(A) \rightarrow \mathbb{R}_{\geq 0}$ with $C_m \rightarrow c(C_m)$ holds for each coalition C_m and $\emptyset \rightarrow c(\emptyset) = 0$. Such a characteristic function assigns the amount $c(C_m)$ the respective coalition C_m can claim with good reasons. In the case of the grand coalition $C_0 = A$, this is the overall cooperation gain G: $c(C_0) = G$. For all other coalitions C_m with $\emptyset \subset C_m \subset A$, these are the amounts $c(C_m)$ these coalitions C_m could realize on their own outside the grand coalition C_0 and therefore in competition with the rest of the grand coalition, i.e. the residual coalition RC_m with $RC_m = C_0 \setminus C_m$.

In the second step, the shape of a distribution function v with v: $A \rightarrow \mathbb{R}_{\geq 0}$ and $A_n \rightarrow v(A_n) = v_n$ for each actor A_n is determined by calculating the distribution function values v_n. Only two information sources are considered to calculate these values. On the one hand, these are the amounts which each feasible coalition C_m can claim due to the characteristic function c from the first step. On the other hand, the applied game theory solution concept specifies how the distribution function values

v_n are calculated based on the values $c(C_m)$ of the characteristic function c for all feasible coalitions C_m with $m = 0,1,\ldots,2^N - 2$. When all distribution function values v_n are determined, there is a N-tupel $\underline{v} = (v_1,\ldots,v_N)$ as a solution $\underline{v}$ for the respective regarded instance of the generic distribution problem. Every solution $\underline{v}$ assigns a share v_n of the cooperation gain G to each actor A_n of the value chain. This N-tupel $\underline{v}$ is formally equivalent to a solution point L in the N-dimensional non-negative real number space $\mathbb{R}_{\geq 0}{}^N$. The solution point L is represented as a column vector $\vec{v}$, whose transposed representation denoted by a superscript letter (^{T}) is: $\vec{v} = (v_1,\ldots,v_N)^T$.

2.2 The *τ*-Value as a Guideline for the Fair Distribution of Added Values in Value Chains

The τ-value was proposed for the first time by Tijs in 1980 as part of the "Seminar on game theory and mathematical economics" (Tijs 1981). It was further developed by Tijs and Driessen (Driessen 1985; Driessen and Tijs 1982, 1983, 1985; Tijs 1987; Tijs and Driessen 1983, 1986); see also Bilbao et al. 2002; Curiel (1997); Zelewski (2009). Until today, only a few research projects have attempted to apply the τ-value in the area of economics, especially the management of value chains. The corresponding papers, however, are focused on the distribution of fixed costs or overhead costs in single companies (cf. Tijs and Driessen 1986). To the knowledge of the authors, until now relatively little research has been carried out applying the τ-value to the solution of the above mentioned generic distribution problem for added values in value chains.

The standard procedure of game theory to introduce a new solution concept consists of specifying its calculation formulas and its applicability conditions. If the applicability conditions of a solution concept are available in an axiomatized form, it is often argued that the proposed solution concept is the only one that is capable of fulfilling a set of formally specified axiomatic requirements. Critical reflection on the justification of such axioms are rare. One of the drawbacks of such standard procedure is that it takes a purely formalistic approach and regards a rigorous solution concept primarily in terms of its formal calculation and, if possible, its formal axiomatization. From a management point of view, it lacks orientation towards the real problem of a distribution outcome being accepted as fair. The following procedure therefore sets out to justify a game theory solution in an alternative line of reasoning: Starting from the real problem of distributing added values among the actors of a value chain, the solution concept should be developed in an easily understandable manner so that it is derivable from "plausible" or "reasonable" assumptions oriented towards the real problem under consideration. Moreover, it should be possible to have or to give *good reasons* for accepting the resulting solution as *fair* distribution. In the following, the authors try to develop a generally applicable *justification program* for game theory solution concepts oriented towards real problems of added value distribution as exemplified by the specific τ-value solution concept. A major concern of this paper is to reconstruct the τ-value solution concept in a new way with regard to this justification program.

The basic idea of the reconstruction of the τ-value solution concept is to restrict the solution space ${\mathbb{R}_{\geq 0}}^N$ for the generic distribution problem by successively adding *five assumptions* which stem from the real problem of distributing added values achieved cooperatively in a value chain among the cooperating actors.

The first assumption is the *condition of individual rationality*. This condition assumes that every actor in a value chain acts rationally in the sense of the conventional concept of perfect rationality. This causes a restriction of the solution space ${\mathbb{R}_{\geq 0}}^N$, since it would not be rational for an actor A_n to participate in the value chain within the grand coalition C_0 if this coalition yields a smaller utility for this actor compared to his or her leaving the coalition and realizing the amount $c(\{A_n\})$ outside the value chain. Thus the condition of individual rationality can be formulated with the characteristic function c and the feasible solution point L within the solution space as follows:

$$\forall L \in \mathbb{R}^N_{\geq 0}: \quad L = (v_1,\ldots,v_N)^T \geq (c(\{A_1\}),\ldots,c(\{A_N\}))^T \tag{1}$$

The second assumption is the *efficiency condition*. This condition postulates that the added value or cooperation gain G is distributed exactly ("efficiently") among all actors A_n of the grand coalition $C_0 = \{A_1,\ldots, A_N\}$. On the one hand, it would be irrational to distribute less than the added value G, because this would necessarily entail a loss of Pareto optimality. On the other hand, it would be impossible to distribute more than the added value G. Thus the following equation will hold:

$$\forall L \in \mathbb{R}^N_{\geq 0}: \quad L = (v_1,\ldots,v_N)^T \rightarrow \sum\nolimits_{n=1}^{N} v_n = c(C_0) = G \tag{2}$$

The efficiency condition implies a further restriction of the solution space ${\mathbb{R}_{\geq 0}}^N$, since all the solutions of the distribution problem that fulfil the assumption of individual rationality as well as the assumption of efficiency are solution points L on a hyperplane H in the N-dimensional solution space ${\mathbb{R}_{\geq 0}}^N$.

The third assumption is the *rationality condition for maximum allocable shares* of the added value. This condition has the character of a condition of *collective rationality*, since it mirrors the rational consideration of all $N-1$ actors of the *marginal coalition* MC_n with $MC_n = C_0 \backslash \{A_n\} = \{A_1,\ldots,A_{n-1},A_{n+1},\ldots, A_N\}$ to grant actor A_n at most the share $v_{n.max}$ of the added value G, so that the added value G would decrease if actor A_n left the grand coalition $C_0 = \{A_1,\ldots,A_N\}$. This rationality condition requires the following where $c(C_0) = G$ from formula (2):

$$\forall n = 1,\ldots,N \; \forall v_n \in \mathbb{R}_{\geq 0}: v_n \leq v_{n.max} \wedge v_{n.max} = c(C_0) - c(MC_n) = G - c(MC_n) \tag{3}$$

In the solution space, the point at which the maximum allocable share $v_{n.max}$ of the added value G is assigned to each actor A_n, is called the upper bound UB or *ideal point* for the distribution of an added value G.

The fourth assumption is a *rationality condition for minimum allocable shares* of the added value. This condition also has the character of a condition of *collective rationality*, since the condition reflects the rational consideration of all $N-1$ actors of the *marginal coalition* MC_n with $MC_n = C_0 \backslash \{A_n\}$ to grant actor A_n at least the share $v_{n.min}$ of the added value G with which she or he could credibly threaten to found at least one outsider coalition. An *outsider coalition* is a coalition $AC_{n.q}$ of former actors of the value chain, which leaves the grand coalition C_0, at least hypothetically, and has at least the actor A_n as "leader." Since the same actor A_n can lead several outsider coalitions, the second index q is used to differentiate all outsider coalitions led by the same actor A_n. Furthermore, an outsider coalition can never contain all actors of the grand coalition C_0, since no non-empty residual coalition would exist whose actors could generate the added value G to be distributed.

For the τ-value, it is important which outsider coalitions $AC_{n.q}$ enable an actor A_n to threaten in a *believable* manner. In this paper, it is assumed that the characteristic function is partially known due to the amounts $c(AC_{n.q})$ for each outsider coalition led by an actor A_n. The actor A_n offers all other actors of the outsider coalition $AC_{n.q}$ an optimal incentive to defect. This incentive consists of so-called side payments and ensures that the utility of each other actor out of the considered outsider coalition $AC_{n.q}$ is the same as his or her maximum utility in the grand coalition C_0. In this case, the actors in an outsider coalition have no incentive to remain in the grand coalition C_0. The operationalization of the side payments takes place in the following way, with the amount $c(\{A_n\}|AC_{n.q})$ realizable by actor A_n in the outsider coalition $AC_{n.q}$ and with the index set $IN_{n.q}$ of indices of all actors belonging to this outsider coalition:

$$\forall \oslash \subset AC_{n.q} \subset A : \{A_n\} \subset AC_{n.q} \rightarrow \ldots \\ c\left(\{A_n\} \middle| AC_{n.q}\right) = c\left(AC_{n.q}\right) - \sum\nolimits_{m \in \left(IN_{n.q} \backslash \{n\}\right)} v_{m.max} \tag{4}$$

The amounts $c(\{A_n\}|AC_{n.q})$ utilized by actor A_n in threatening to found an outsider coalition may be negative. In this case a threat would not be believable. Thus this case is excluded from the rationality condition for minimum allocable shares $v_{n.min}$ of the added value G. The complete rationality condition is as follows:

$$\forall n = 1,\ldots,N \, \forall v_n \in \mathbb{R}_{\geq 0}: v_n \geq v_{n.min} \wedge v_{n.min} = \max\{c_{n.1}; c_{n.2}; 0\} \tag{5}$$

with:

$$c_{n.1} = c\left(\{A_n\} \middle| AC_{n.q}\right) = c\left(\{A_n\}\right) \text{ for } AC_{n.q} = \{A_n\}$$

$$c_{n.2} = max\left\{ \begin{array}{r} c\left(\{A_n\}|AC_{n.q}\right) = c\left(AC_{n.q}\right) - \sum_{m \in \left(IN_{n.q} \setminus I\{n\}\right)} v_{m.max} \middle| \ldots \\ \oslash \subset AC_{n.q} \subset A \wedge \{A_n\} \subset AC_{n.q} \end{array} \right\}$$

The lower bound LB for the distribution of the added value G is that point in the solution space $\mathbb{R}_{\geq 0}{}^N$ in which the minimum allocable shares $v_{n.min}$ of the added value G are assigned to each actor A_n where $n = 1,\ldots,N$. The lower bound LB is often called the *threat point* (e.g. Kuhn et al. 1996).

The fifth and last assumption is introduced as an *integrity condition* for the relation of the lower bound LB to the upper bound UB for the shares of the added value G to be distributed, as well as for the hyperplane H for the compliance with the efficiency condition to avoid particular complications outside the scope of this paper (for details of these complications see Zelewski 2009, pp. 137–141 and 156–167). Games which satisfy this integrity condition are designated quasi-balanced games in the game theory literature:

$$\begin{array}{l} \forall LB, UB \in \mathbb{R}^N_{\geq 0} \forall G \in \mathbb{R}_{>0}: \\ \left(LB = \begin{pmatrix} v_{1.min} \\ \ldots \\ v_{N.min} \end{pmatrix} \wedge UB = \begin{pmatrix} v_{1.max} \\ \ldots \\ v_{N.max} \end{pmatrix} \wedge c(C_0) = G \right) \\ \rightarrow \left(\sum_{n=1}^{N} v_{n.min} \leq G \leq \sum_{n=1}^{N} v_{n.max} \wedge LB \leq UB \right) \end{array} \tag{6}$$

It can be shown (Zelewski 2009, pp. 153–163) that exactly one solution point L exists in the N-dimensional non-negative real number space $\mathbb{R}_{\geq 0}{}^N$ that fulfils all five aforementioned assumptions for the generic distribution problem concerning individual and collective rationality as well as efficiency and integrity, i.e. the formulas (1), (2), (3), (5), and (6). This *unique solution point* is the τ-value. The τ-value is a special solution point L_τ which is determined by a convex – or to put it in less precise but more intuitive terms: linear – combination of the upper bound (ideal point) UB and the lower bound (threat point) LB with the weighting factor γ and $0 \leq \gamma \leq 1$. Therefore it must hold true that:

$$\begin{array}{l} \forall L, LB, UB \in \mathbb{R}^N_{\geq 0} \forall G \in \mathbb{R}_{>0}: \\ \left(\begin{array}{l} L = \begin{pmatrix} v_1 \\ \ldots \\ v_N \end{pmatrix} \wedge \sum_{n=1}^{N} v_n = G \wedge LB = \begin{pmatrix} v_{1.min} \\ \ldots \\ v_{N.min} \end{pmatrix} \wedge UB = \begin{pmatrix} v_{1.max} \\ \ldots \\ v_{N.max} \end{pmatrix} \\ \wedge \sum_{n=1}^{N} v_{n.min} \leq G \leq \sum_{n=1}^{N} v_{n.max} \wedge LB \leq UB \end{array} \right) \\ \rightarrow \left(\dot{\exists} L_\tau \in \mathbb{R}^N_{\geq 0} \exists \gamma \in \mathbb{R}_{\geq 0}: \quad L_\tau = \gamma \bullet LB + (1-\gamma) \bullet UB \wedge 0 \leq \gamma \leq 1 \right) \end{array} \tag{7}$$

In its most widespread representation in literature (e.g. Branzei et al. 2005; Curiel 1997; Tijs 1987), the τ-value is explicitly specified for each actor A_n. After some simple transformations using the efficiency condition and with special regard to the frequently ignored degenerated case $\sum_{n=1}^{N} v_{n.max} = \sum_{n=1}^{N} v_{n.min}$, the common formula for calculating the τ-value produces:

$$\forall n = 1,\ldots,N:\; v_{n.\tau} = \gamma \bullet v_{n.max} + (1-\gamma) \bullet v_{n.min} \tag{8}$$

with:

$$\begin{aligned} \gamma &= \frac{G - \sum_{n=1}^{N} v_{n.min}}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}}; \quad && \text{if} \quad \sum_{n=1}^{N} v_{n.max} \neq \sum_{n=1}^{N} v_{n.min} \\ \gamma &\in [0;1]; && \text{if} \quad \sum_{n=1}^{N} v_{n.max} = \sum_{n=1}^{N} v_{n.min} \end{aligned} \tag{9}$$

3 Model-Analytic Characterization and Critique of the τ-Value

3.1 Characteristic Properties of the τ-Value

The τ-value according to Eq. (8) shows that the τ-value is to be considered as a typical *compromise solution* for each actor A_n between its maximum allocable share of the added value $v_{n.max}$ (i.e. the nth component of the ideal point UB) and its minimum allocable share of the added value $v_{n.min}$ (i.e. the nth component of the threat point LB). The characterization of the τ-value as a compromise solution for the generic distribution problem presents another good reason to accept the distribution of the added value as fair, since intuitive preconceptions about what is accepted as fair contain the normative connotation that fair distribution should be based on a compromise between the interests of the involved actors. In the case of the τ-value solution concept, these interests are operationally specified with the aid of the threat point and the ideal point.

If the efficiency condition is additionally taken into account, allowing the weighting factor γ to be specified numerically, it is possible to represent the τ-value in a very easily intelligible manner as the convex combination of the upper bound UB (ideal point) and the lower bound LB (threat point) lying on the hyperplane H within the N-dimensional solution space $\mathbb{R}_{\geq 0}{}^{N}$ and therefore satisfying the efficiency condition. This is illustrated in Fig. 1 for the special case of three actors, i.e. $N = 3$.

The τ-value is not only a typical compromise solution but is also characterized by two additional characteristic properties. Firstly, the compromise solution is *Pareto efficient* in terms of the above mentioned efficiency condition. Thus the

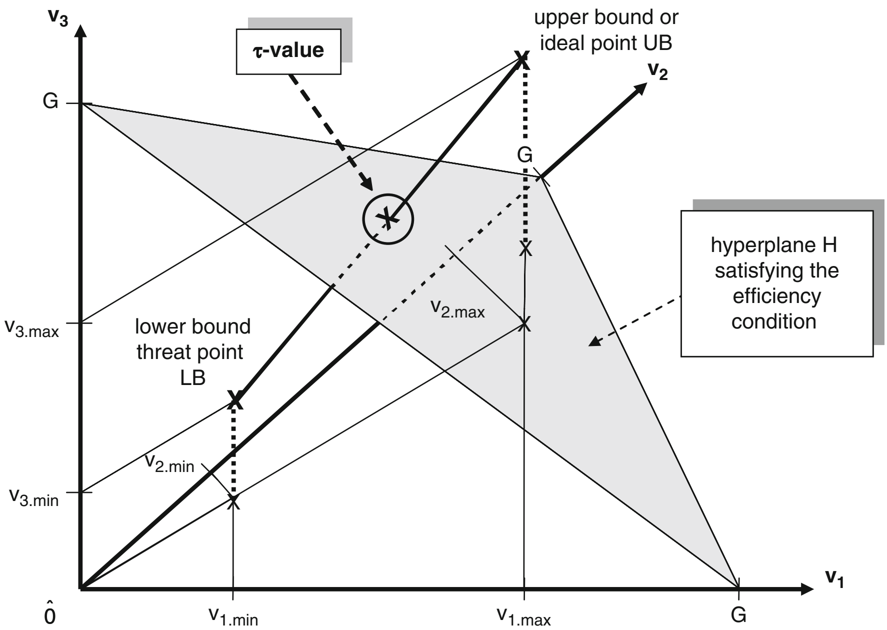

Fig. 1 Illustration of the τ-value

τ-value can be understood as an *efficient compromise* (Driessen 1987). Secondly, the compromise solution represents the intuitively *simplest compromise* between the threat point and the ideal point. It is impossible to construct a simpler connection between these two points in the solution space $\mathbb{R}_{\geq 0}{}^{N}$ than the direct rectilinear distance determined by formulas (8) and (9).

3.2 A New Interpretation of the τ-Value

A new interpretation of the τ-value is given from the perspective of the actors cooperating in the network of a value chain. This interpretation clearly differs from the description of the τ-value in the game theory literature. But it reveals the economic content of the τ-value more because it ties in with *the scope of possible actions* that empower an actor to contribute to the realization of added value in a value chain – both in a positive and a negative way.

It is required as a new assumption that solution concepts for the generic distribution problem fulfil an *operational fairness criterion*: the greater the bargaining power of an actor A_n, the greater his or her share $v_{n.\tau}$ of the added value G. The bargaining power of an actor A_n depends on two opposed effects. On the one hand, the bargaining power of an actor A_n is measured by the contribution the actor would make if she or he took part in the marginal coalition MC_n and thus would make this marginal coalition a grand coalition C_0. This *positive network effect* is the maximum allocable share $v_{n.max}$ of the added value; see formula (3). On the other hand, the bargaining power of an actor A_n is measured by his or her threat potential that is build-up of the believable threat to found at least one outsider coalition $AC_{n.q}$. This *negative network effect* has been specified as the minimum allocable share $v_{n.min}$ of the added value; see formula (5).

The good reasons for accepting the distribution of the added value G among the actors A_n in a value chain, and therefore a feasible solution L of the generic distribution problem as fair, can be specified as follows: It is regarded as fair to grant actor A_n a share v_n of the added value G which is positively correlated with the actor's contribution to building the grand coalition (positive network effect) and with the threat potential to preventing the grand coalition from coming into existence (negative network effect).

The aforementioned characterization of a fair distribution of the added value G is mainly qualitative. Thus, this characterization offers some scope for interpretation regarding the numerical determination of the shares v_n for all actors A_n in a value chain. A *quantification* of the fairness criterion in the form of a calculation rule for the τ-value is desirable. This calculation rule should be as easy as possible to understand in order to gain acceptance in management practice. The calculation rule employed is the following *new type* of formula to calculate the τ-value:

$$\forall n = 1,\ldots,N:$$
$$v_{n.\tau} = \begin{cases} \alpha \bullet \frac{v_{n.max}}{\sum_{n=1}^{N} v_{n.max}} \bullet G + \beta \bullet \frac{v_{n.min}}{\sum_{n=1}^{N} v_{n.min}} \bullet G; & \text{if } \sum_{n=1}^{N} v_{n.max} \neq \sum_{n=1}^{N} v_{n.min} \\ v_{n.max} = v_{n.min}; & \text{if } \sum_{n=1}^{N} v_{n.max} = \sum_{n=1}^{N} v_{n.min} \end{cases} \tag{10}$$

with:

$$\alpha = \frac{G - \sum_{n=1}^{N} v_{n.min}}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}} \bullet \frac{\sum_{n=1}^{N} v_{n.max}}{G}$$
$$\wedge \quad \beta = \frac{\sum_{n=1}^{N} v_{n.max} - G}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}} \bullet \frac{\sum_{n=1}^{N} v_{n.min}}{G} \tag{11}$$

Three properties of the new formula type are particularly remarkable. Firstly, this calculation rule is characterized by capturing the bargaining power of the actor A_n by two summands. The first summand reflects the bargaining power of the actor according to his or her contribution to the grand coalition (positive network effect or coalition contribution) by means of the share $v_{n.max}$ of the added value G. The second summand represents the bargaining power of the actor due to his or her threat potential to dissolve the grand coalition (negative network effect or threat potential) by means of the share $v_{n.min}$ of the added value G. Secondly, the coalition contribution and the threat potential of actor A_n are not measured absolutely, but are relativized with respect to the sums of the coalition contributions and the threat potentials respectively. This is a normalization of the coalition contribution and of the threat potential of actor A_n regarding the upper bound UB and the lower bound LB respectively. Thirdly, the coalition contribution and the threat potential of actor A_n are weighted with the factors α and β respectively. These weighting factors connect the share v_n of the added value G that an actor A_n receives in a typical proportional manner with the two central aspects of bargaining power, the coalition contribution $v_{n.max}$ and the threat potential $v_{n.min}$. This *property of proportionality* plays an important role for the acceptability of the τ-value, because proportionality is frequently assumed as a plausible and convincing essence of fairness. However, the proportionality between the share v_n of the added value G on the one side and the coalition contribution and the threat potential on the other side does not apply exactly, but only in a rough approximation (for details see Zelewski 2009, pp. 184–189 and 224–230).

For interested readers, it is shown that both sets of formulas for the calculation of the τ-value – the formulas (8) and (9) popular in the game theory literature on the one hand and the new formulas (10) and (11) presented here on the other hand – are equivalent from a mathematical point of view.

In the game theory literature, the τ-value according to formula (8) is usually regarded with respect to each actor A_n as a convex combination of his or her coalition contribution $v_{n.max}$ (as a component of the ideal point UB) and his or her threat potential $v_{n.min}$ (as a component of the threat point LB) with the weighting factor γ and $0 \leq \gamma \leq 1$:

$$\forall n = 1,\ldots,N: \quad v_{n.\tau} = \gamma \bullet v_{n.max} + (1-\gamma) \bullet v_{n.min} \tag{12}$$

In consideration of the efficiency condition according to formulas (2) and (9), for the τ-value follows:

$$\begin{aligned} &\forall n = 1,\ldots,N: v_{n.\tau} = \gamma \bullet \ v_{n.max} + (1-\gamma) \ \bullet \ v_{n.min} \\ &\quad \wedge \quad \sum\nolimits_{n=1}^{N} v_{n.\tau} = G \\ &\Leftrightarrow \sum\nolimits_{n=1}^{N} (\gamma \bullet v_{n.max} + (1-\gamma) \bullet v_{n.min}) = G \\ &\Leftrightarrow \gamma = \frac{G - \sum\nolimits_{n=1}^{N} v_{n.min}}{\sum\nolimits_{n=1}^{N} v_{n.max} - \sum\nolimits_{n=1}^{N} v_{n.min}}; \quad \text{if} \quad \sum\nolimits_{n=1}^{N} v_{n.max} \neq \sum\nolimits_{n=1}^{N} v_{n.min} \end{aligned} \tag{13}$$

$$\textit{Standard case: } \sum\nolimits_{n=1}^{N} v_{n.max} \neq \sum\nolimits_{n=1}^{N} v_{n.min}$$

By representing the τ-value for all involved actors A_n with $n = 1,\ldots,N$ as a solution point L_τ in the N-dimensional solution space $\mathbb{R}_{\geq 0}{}^N$, it applies that:

$$L_\tau = \gamma \bullet \begin{pmatrix} v_{1.max} \\ \ldots \\ v_{N.max} \end{pmatrix} + (1-\gamma) \bullet \begin{pmatrix} v_{1.min} \\ \ldots \\ v_{N.min} \end{pmatrix} \quad \wedge \quad \gamma = \frac{G - \sum_{n=1}^{N} v_{n.min}}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}} \tag{14}$$

$$\Leftrightarrow L_\tau = \frac{G - \sum_{n=1}^{N} v_{n.min}}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}} \bullet \begin{pmatrix} v_{1.max} \\ \ldots \\ v_{N.max} \end{pmatrix} + \left(1 - \frac{G - \sum_{n=1}^{N} v_{n.min}}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}}\right) \bullet \begin{pmatrix} v_{1.min} \\ \ldots \\ v_{N.min} \end{pmatrix} \tag{15}$$

$$\Leftrightarrow \quad L_\tau = \frac{G - \sum_{n=1}^{N} v_{n.min}}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}} \bullet \frac{\sum_{n=1}^{N} v_{n.max}}{G} \bullet \begin{pmatrix} \frac{v_{1.max}}{\sum_{n=1}^{N} v_{n.max}} \bullet G \\ \ldots \\ \frac{v_{N.max}}{\sum_{n=1}^{N} v_{n.max}} \bullet G \end{pmatrix} + \frac{\sum_{n=1}^{N} v_{n.max} - G}{\sum_{n=1}^{N} v_{n.max} - \sum_{n=1}^{N} v_{n.min}} \bullet \frac{\sum_{n=1}^{N} v_{n.min}}{G} \bullet \begin{pmatrix} \frac{v_{1.min}}{\sum_{n=1}^{N} v_{n.min}} \bullet G \\ \ldots \\ \frac{v_{N.min}}{\sum_{n=1}^{N} v_{n.min}} \bullet G \end{pmatrix} \tag{16}$$

Definitional introduction of the weighting factors α and β in formula (11) allows the formula (16) to be represented in a simplified but equivalent form:

$$L_\tau = \alpha \bullet \begin{pmatrix} v_{1.max} \\ \ldots \\ v_{N.max} \end{pmatrix} \bullet \frac{G}{\sum_{n=1}^{N} v_{n.max}} + \beta \bullet \begin{pmatrix} v_{1.min} \\ \ldots \\ v_{N.min} \end{pmatrix} \bullet \frac{G}{\sum_{n=1}^{N} v_{n.min}} \tag{17}$$

For the components $v_{n.\tau}$ of the τ-value $\underline{v}_\tau$ and the corresponding solution point L_τ in the solution space $\mathbb{R}_{\geq 0}{}^N$, it immediately follows that:

$$\forall n = 1,\ldots,N: \quad v_{n.\tau} = \alpha \bullet \frac{v_{n.max}}{\sum_{n=1}^{N} v_{n.max}} \bullet G + \beta \bullet \frac{v_{n.min}}{\sum_{n=1}^{N} v_{n.min}} \bullet G \tag{18}$$

Formula (18) conforms to formula (10) with respect to the standard case.

Special case: $\sum_{n=1}^{N} v_{n.max} = \sum_{n=1}^{N} v_{n.min}$

In this special case, the upper bound UB and the lower bound LB have to be the same ($UB = LB$) with respect to the fulfilment of the integrity condition of formula (6) and with respect to v: $A \rightarrow \mathbb{R}_{\geq 0}$ for every distribution function v. Therefore it holds $v_{n.min} = v_{n.max}$ for each actor A_n with $n = 1, \ldots, N$. Thus the upper bound UB and the lower bound LB lie on the same point on the hyperplane H in the solution space ${\mathbb{R}_{\geq 0}}^N$. This means for the representation of the τ-value as a convex combination of the ideal point (the upper bound UB) and the threat point (the lower bound LB) according to formula (9) that for the weighting factor γ with $0 \leq \gamma \leq 1$ each value γ out of the real-valued interval [0;1] can be chosen arbitrarily based on the coincidence of the ideal point and the threat point:

$$\begin{aligned}
&\forall n = 1,\ldots,N\ \forall \gamma \in [0;1]: \\
&\qquad v_{n.\tau} = \gamma \bullet v_{n.max} + (1-\gamma) \bullet v_{n.min} \quad \wedge \quad v_{n.min} = v_{n.max} = v_{n.\tau} \\
&\quad \rightarrow v_{n.\tau} = \gamma \bullet v_{n.\tau} + (1-\gamma) \bullet v_{n.\tau} \\
&\quad \rightarrow v_{n.\tau} = \gamma \bullet v_{n.\tau} + v_{n.\tau} - \gamma \bullet v_{n.\tau} = v_{n.\tau} \quad \text{true for every } \gamma \in [0;1]
\end{aligned} \tag{19}$$

Special case: $\sum_{n=1}^{N} v_{n.max} \leq \sum_{n=1}^{N} v_{n.min}$ with $v_{n.max} < v_{n.min}$ for at least one actor A_n.

This case is ruled out by the integrity condition according to formula (6). It therefore requires no further consideration.

3.3 Controversial Aspects of the τ-Value

The inquiry presented here represents the thesis that the τ-value as a game theory solution concept for the above mentioned generic distribution problem is an interesting approach to operationalizing the generally only vague conceptions regarding the fairness of distribution outcomes. Basically, there are three objections of varying importance to this thesis.

Firstly, good arguments exist for and against the question of whether it is “adequate” to apply the operationalization of fairness only to the bargaining power of each actor A_n. Furthermore, it is also possible to question whether it is “adequate” to measure this bargaining power by the actor’s contribution to the grand coalition (positive network effect) and by the actor’s threat potential to dissolve the grand coalition (negative network effect). This criticism relates to both formulas (10) and (11) as a calculation rule for the τ-value.

This first objection against the τ-value is relatively weak compared to the two following objections. Both formulas (10) and (11) are not at all constitutive for the τ-value. Furthermore, they are entirely dispensable because the τ-value, as shown in Sect. 2.2, inevitably results only from the five assumptions according to the formulas (1), (2), (3), (5) and (6) without recourse to those two formulas. The formulas (10) and (11) only represent an *equivalent* representation of the usual representation of the τ-value with the help of the two formulas (8) and (9). However, this equivalent representation has the advantage that the solution concept of the τ-value can be interpreted very strongly from an economic perspective.

Additionally, there is an immanent weakness in this critical scepticism as to whether the operationalization of fairness with the aid of both formulas (10) and (11) is "adequate," because it doubts the adequacy of a distinct solution concept without expanding on the relevant adequacy criteria. As long as this criterion of adequacy is not explained, the criticism of the apparent inadequacy of a specific solution concept has no basis. On the contrary, it can be seen as a special asset of the τ-value that it makes a concrete discussion proposition for the operationalization of fairness, which may lead to alternative, but equally concrete, operationalization propositions.

Secondly, the assumption of collective rationality concerning the minimum allocable shares of the added value represents a very critical aspect of the τ-value. This assumption is based on an operationalization of the meaning of a "believable" threat. The credibility of a threat is always a matter of discretion that depends on subjective evaluations and for that reason can always be questioned – from the perspective of other equally subjective evaluations. Hence the solution concept of the τ-value has a weakness in this area. Operationalization of the meaning of a "believable" threat with outsider coalitions only needs to be questioned to undermine the whole solution concept; see for example Fromen 2004, p. 187. To eliminate this weakness as effectively as possible, the solution concept of the τ-value conceptualizes the credibility of threats with outsider coalitions in a particularly rigid way. This was explained in detail in association with the formula (5) in Sect. 2.2.

Thirdly, the assumption of the integrity condition – see formula (6) for the restriction to the class of quasi-balanced games – is a problem. It was introduced in Sect. 2.2 in relation to avoiding particular complications outside the scope of this paper. Without discussing the details of these complications, the meaning of the integrity condition of formula (6) for the solution concept of the τ-value can be described as following. Without this integrity condition, the first four assumptions according to formulas (1), (2), (3) and (5) can only prove the existence of *at most* one solution point L in the N-dimensional non-negative real number space $\mathbb{R}_{\geq 0}{}^N$ that fulfils these four assumptions. It does not assure the existence of *at least* one solution point L at the same time. This is because "pathological" cases exist, which do not satisfy the formula (6). In these "pathological" cases there is no solution concept that satisfies the four assumptions according to the formulas (1), (2), (3) and (5) at the same time. Thus the τ-value does not exist in these cases. Only the addition of the integrity condition of formula (6) ensures that not only a minimum, but also a maximum of one solution point L exists at the same time in the N-dimensional non-negative real number space $\mathbb{R}_{\geq 0}{}^N$ that fulfils the five assumptions. This exact one single solution point L is the τ-value, as shown above.

The limitation of the τ-value to quasi-balanced games can be seen as a substantial weakness of the τ-value. But a weakness would only exist if theoretically interesting or practically relevant instances of the generic distribution game that do not belong to the class of quasi-balanced games were specified. This has not been the case up to now. In fact, it can be shown (Zelewski 2009, pp. 163–166) that those instances of the generic distribution game not belonging to the class of quasi-balanced games are not relevant to real problems of the distribution of an added value.

4 Conclusions

This article has shown how the vague *understanding of fairness* that dominates in practice can be *defined* with the aid of game theory by applying the game theory solution concepts to the generic distribution problem. Special importance was attached to the fact that the τ-value inevitably results if a small number of assumptions with respect to individual and collective rationality, efficiency and integrity is accepted. This matches the justification program introduced at the beginning and presents a game theory solution concept in which good reasons are cited in order for the resulting solutions to be accepted as fair distribution.

The authors consider the assumptions that need to be accepted in order to use the τ-value to be so weak that this solution concept has *great potential* for *general acceptance*. Other game theory solution concepts, for example the Shapley value and the nucleolus, demand the acceptance of far more abstract, often only formally precisely definable assumptions. Hence they have considerably lower general acceptance potential. Additionally, other game theory solution concepts, for example the core of a game, can be traced back to a few plausible assumptions. However, they have the disadvantage that they do not exist for many instances of the generic distribution problem or have multiple, often even an infinite number of solutions. From a practical perspective, neither is acceptable. For the aforementioned reasons, the τ-value both offers to unite the advantage of *good reasons* for the *acceptability* of distribution outcomes as *fair* with the pragmatic assumptions of the *existence* and *uniqueness* for a – in relation to other game theory solution concepts – broad range of instances of the generic distribution problem.

As *managerial insights* three aspects can be gained from the explanations of the sections of the chapters above.

Firstly, game theory solution concepts such as the τ-value offer a "reasonable," because provable with good reasons, and justifiable basis for the distribution of added values in value chains. Thanks to the explicability of the good reasons, there is a high chance that the companies cooperating in a value chain will accept the distribution of the collectively realized added values as fair. However, the distribution of an added value determined with the aid of the τ-value can always only represent the source of a discussion about the fair distribution of a collectively realized added value, and not the final outcome of the distribution. Because the τ-value is, like any other concept for distributing added values, based on a few specific assumptions, it can, but need not, be accepted as "plausible" or "reasonable." Propositions for the distribution of added values on the basis of the τ-value indeed form a promising basis for discussion, because such a distribution proposition can be justified with good reasons. However, good reasons never offer an assurance that – especially on the basis of other assumptions – even more convincing reasons for an alternative distribution proposition can be found.

Secondly, it was presupposed in this contribution, that the added value G can be defined precisely and quantified monetarily, but this assumption will only rarely be fulfilled in practice. Hence for adaptability of the game theory solution concepts presented here, the management of the value chain needs to ensure that the added value to be distributed can also be defined in concrete terms. This can lead to two basic practical problems. On the one hand, agreement needs to be reached inside a value chain as to the concrete economic scale on which the added value to be distributed is to be determined and from which sources the information required to determine it can be drawn. This is not a trivial task and cannot be analysed in detail in this article. On the other hand, how the management of a value chain is defined needs to be clarified, because a value chain according to the agreements made at the beginning is characterized by the cooperation of legally autonomous companies (autonomous actors). If a value chain is dominated by a focal company, the management of a value chain can be equated in a relatively simple way with the management of the focal company. However, as a side condition it must be considered that the management of the focal company can only make decisions that do not jeopardize the stability of the value chain – and from a game theory perspective the stability of the grand coalition. There is also the question of what the management of a value chain is if the special case of a focal company does not apply. In this non-focal case, one option is to revert to the game theory concept of coalition formation games. With the aid of this concept, it is possible to examine how coalitions of legally autonomous companies in the form of a value chain come about. However, even such coalition formation games so far offer no starting points at which to determine how in value chains without a focal company the added value to be distributed should be determined in concrete terms. Extensive academic research is still required on this point.

Thirdly, the management of companies that cooperate in a value chain must always be aware of the fact, that game theory solution concepts assume the rationality of all involved actors (companies). This rationality of actors manifests itself mainly in the conditions of individual and collective rationality. However, it is also based on assumptions such as the efficiency condition that can also be seen as an expression of collective rationality. Negotiations in real existing value chains about the "fair" distribution of added values are by no means always affected by the rationality of the negotiating partners. Rather, the management must be aware that the process of negotiation on the fair distribution of added values is also influenced by the fact that the rationality of actors does frequently not correspond to classic game theory. Such influences can extend from the many determinants of the so-called bounded rationality that is increasingly attracting interest in economic analysis, up to a large number of effects of apparently or even real irrational behaviour. All these influences "beyond" the conception of classic rationality are not covered by the game theory solution concept introduced here. Hence the management of companies that cooperate in a value chain must always be aware that the game theory solution concept considered here only covers one part of the real process of negotiation over fair distributions of added values.

The τ-value has the advantage, that it can be referred with the aid of the new interpretation presented in Sect. 3.2, directly to the bargaining power of the actors cooperating in a value chain. It has been shown, that the τ-value immediately results from the positive and the negative network effects that an actor can contribute to the realization of an added value in a value chain. Hence the τ-value represents an interesting approach, which allows the aspect of the bargaining power to be included in the determination of distribution outcomes that can be accepted as fair.

One problem in the determination of the τ-value needs to be mentioned that is a reason for *further research*. It results from violation of the requirement of minimal knowledge. Knowledge of the values of the characteristic function c for all possible coalitions is also needed for the τ-value. This represents a serious barrier to the implementation of the τ-value in practice, because normally it cannot be assumed, that enough knowledge and enough time are available to determine the concrete function values $c(C_m)$ for all possible coalitions C_m. Hence "intelligent" approaches are needed, to reduce the effort involved in their determination. It should incidentally be mentioned that this problem of the prohibitive amount of effort required to determine the concrete values of the characteristic function for all possible coalitions does not represent a specific problem for the solution concept of the τ-value introduced here. It actually concerns all common game theory solution concepts such as the Shapley value and the nucleolus.

But considering the τ-value, it is not necessary to consider all coalitions C_m with $\emptyset \subset C_m \subset C_0$ for the calculation of the function values $c(AC_{n.q})$ of the characteristic function c for the outsider coalitions $AC_{n.q}$. A first approach has already been developed (Zelewski 2009, pp. 233–236 and 244–255). It is based on the pragmatic thought, that experienced managers often know, that an outsider coalition $AC_{n.q}$ is *insignificant*, because the actor A_n, who leads this outsider coalition, cannot pose a credible threat with the significant amount $c(AC_{n.q}) > 0$, that he or she could realize in this outsider coalition. Additionally, an experienced manager can know that an actor A_n is *not relevant* to the calculation of the τ-value, because this actor A_n cannot lead any outsider coalition $AC_{n.q}$ with a credible threat of the amount $c(AC_{n.q}) > 0$. If this knowledge about insignificant outsider coalitions $AC_{n.q}$ and not relevant actors A_n can be considered additionally, the effort required to calculate the τ-value can be reduced significantly. This requires a few algorithmic modifications regarding the concrete calculation of τ-value. These changes will be discussed in detail in a later publication.

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Part IV

Value Chain Models: Decision-Making

Chair:

Per Engelseth

Habit, Affect, and Cognition: A Constructivist Model on How They Shape Decision Making

Jörg Kraigher-Krainer

Abstract This paper presents a cybernetic decision model linking discrepancy theory to perceived risk and decision-type research. A scarce set of variables is used for modelling the pre-purchase, purchase and post-purchase phase. Five decision types are proposed and a bigger picture on consumer perception, decision making, and customer value creation is provided.

Keywords Customer value • Decision types • Emotion • Habit • Perceived risk • Prosperity • Schema theory

1 Introduction

Numerous concepts assume that there are at least two routes to a decision: a more effortful and a less effortful one, the latter being a traditional core competency of consumer researchers (Rothschild 1984). Explanations are provided by *involvement research* (low effort stems from low involvement; e.g., Krugman 1965), *perceived risk research* (low effort stems from lack of risk; e.g., Bauer 1960), and *decision type research* (low effort stems from well-established buying cycles and is termed *habitual behaviour*, e.g., Howard and Sheth 1967). All three explanations are widely accepted and have a strong influence on marketing scholars and practitioners alike.

Discrepancy theories have an even longer tradition and can be traced back at least to the ancient Greek. In marketing, they have turned out to be a particularly helpful in conceptualizing the customer satisfaction construct (Oliver 1980). According to these approaches, people compare their lives to multiple internal standards about products, other people, income, or goals. Standard disconfirmation

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_10,

may appear in both directions: If the standard is higher than the current signal ("*upward comparison*") we will experience disappointment; if the reference point is lower than the current signal ("*downward comparison*") we are pleased. Powers (1973) with his contribution shows that such comparisons can be conceptualized within a hierarchical control-system. Rooted in Norbert Wiener's cybernetic approach, he proposes to grasp behaviour as the control of input, not output. The input quantities are compared to internal reference signals. In case of a deviation we experience a disturbance and continue to alter the input quantities until the reference signal is met within a zone of tolerance. Reference signals are hierarchically organized meaning that the higher order system (e.g., a goal) controls the lower order system (e.g., an activity).

The purpose of this paper is to unify the seminal and influential research streams mentioned above. By borrowing Power's fundamental idea a respective model is presented, offering a bigger picture on human life, decision making, and satisfaction. Given that the foremost purpose of economy is to contribute to the prosperity of the customer, a better understanding of decision processes enhances substantially the understanding of value creation in markets, in particular the creation of *customer value*. Empirical results are not presented herein. Despite their supporting evidence they will have to be reported separately due to volume restrictions.

2 The Proposed Model

The model is depicted in Fig. 1. It shows perception as a continuous construction process by a perceiving *Me* (area above broken line) dealing with *entities E* (people, objects, brands, activities, information, bodily sensations etc.) coming from the peripheral nervous system (area below broken line).

The *Me* selects from the environment what (1) is necessary to keep control of current activities, (2) has a chance of giving pleasure or meets our momentary interests, (3) could be threatening. For instance, while driving through town, we (1) check the traffic peripherally while keeping our attention system free for (2) a billboard with a funny picture, or (3) a pedestrian that might overlook us. Most entities do not meet these conditions, thus they are non-existent (E_0 in Fig. 1). In order to master this control process and to manoeuvre through the environment the brain creates models of the world which are called *schemata* (S), permanent and implicit patterns produced together with each output of the system regarding the question *what will or should happen next* and compared with respective answers from the input system on *what actually happens next* (E_1).

Three of the hierarchies proposed by Powers have to be especially pointed out (as partly proposed by von Glasersfeld 1997): (1) *lower-order quantities* where entities, such as two prices, are compared with each other; (2) *higher-order quantities*, meaning comparisons between an entity, such as a price, and a schema, such as the expected price; and (3) *mental operations*, which address comparison processes between schemata, forecasting events by asking *what-would-happen-if-questions*.

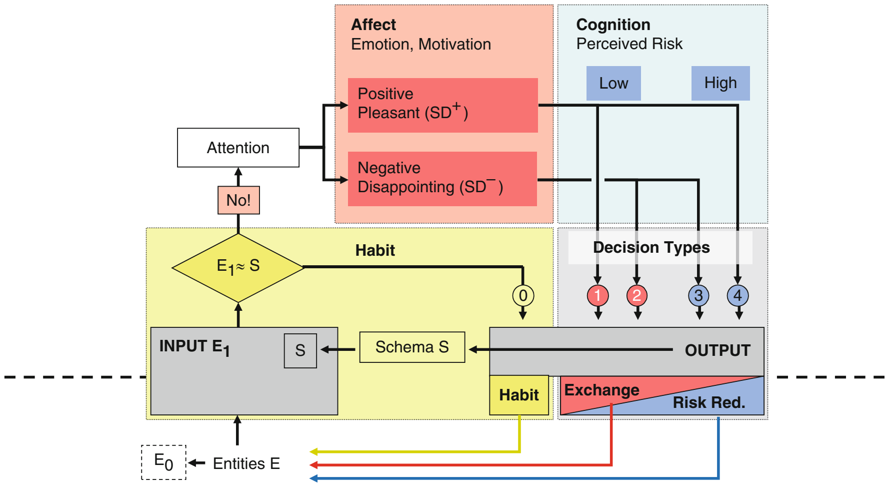

Fig. 1 A cybernetic model of problem solving, decision making and value creation (Adapted from Kraigher-Krainer 2007)

As mental operations are not bound to reality, they are, in principle, unlimited. However, they shape our schemata, which then are confronted with reality and ultimately turn out to be *viable* – which means that they work – or not which causes positive or negative surprise.

Schemata define to a large extent what we perceive and what we perceive is always relative to them (product quality, service performance, price perception, information collection etc.). Their zone of tolerance depends on our motivation and they may also drift without a discrepancy owing to habituation (Solomon 1980); assimilation (Piaget 1963); mere exposure (Zajonc 1968); incidental (Shapiro et al. 1997) or non-declaratory learning (Knowlton and Squire 1994); or forgetting. In the course of time we may even forget executed schema updates and behavioural change and fall back into a former schema. However, only as a consequence of schema discrepancy do we start consciously assessing, comparing, modifying, giving up existing schemata or developing new ones. Of course, may we prefer to ignore or suppress the deviation or apply perceptual defence mechanisms? Dissatisfaction, for instance, combined with an awareness of high switching costs may then lead to a state of happy inertia (White and Yanamandram 2004). Implicit and explicit schema updates increase or decrease expectancies which then serve as a reference point for the next perception, a continuous process that has been fittingly called a *hedonic treadmill* by Brickman and Campbell (1971).

2.1 Habit

As long as a given entity fits the corresponding schema within a zone of tolerance, we are in the realm of habit. It is proposed that habitual behaviour does not engage consciousness, that the vast majority of our daily activities rest on habits and that we do not *learn* in this state. From a cognitive point of view, a man primarily driven by his subconscious habits must appear provocative. However, more recent research on savants (Snyder 2001) uncovers that not handling similar events as practically equal, significantly diminishes the ability to cope with everyday life.

Consumer research showed interest in habits probably before any other field of research (Duesenberry 1949; Katona 1953). Later studies suggest that habits: protect the bottleneck attention (Csikszentmihalyi 1990); help in the efficient management of limited cognitive resources (Khare and Inman 2006); are an important explanation for customer loyalty over and above satisfaction (Burnham et al. 2003); settle down relatively early (Charlton and Ehrenberg 1976) and then resist change (Fiske and Taylor 1984); can be better predictors of behaviour than attitudes or involvement (Gregory and Di Leo 2003); and can be observed in different cultures (Lin and Chang 2003) and consumer- as well as industrial markets (Söderlund et al. 2001). Thus a better understanding of the working principle of habits may be crucial for broadening customer loyalty (Uncles et al. 2003) or research on regret (Zeelenberg and Pieters 2004).

It is important to note that, of course, habits are much more than brand habits (East et al. 1994). Networks of schemata regarding shopping hours, shopping days, product categories, price categories, ways of cuing price cuts, processing modes, ways of using a product, family routines, job-related aspects, routes through town, store habits, financial and banking routines, information source habits etc. are complexly intertwined thus mutually stabilizing and making each other resistant to change. Out of this iceberg arise momentary deviations which are processed but not without relying on the invisible bulk of internalized routines at the same time.

2.2 Affect

In psychology as well as in marketing, one crucial question is: What makes people become consciously aware of something, of some entity, say a marketing impulse? It is proposed that it is the unusual entity, the deviation from the subjective norm, which interrupts habits and routines. The resulting schema discrepancy evokes an emotional reaction of surprise (Vanhamme 2000) which is experienced as either positive and pleasant – signalling success and further pleasure – or negative and disappointing – signalling failures and potential threats.

The interrupting function of emotions in whatever we are currently doing is well documented in literature (Ledoux 1996): Emotions provide information regarding the on-going match between an organism and its environment (Schwarz and Clore 1983) through their updating function and in order to stay in contact with that environment (Fiedler and Bless 2000). Gross (1998) offers a review on approaches grasping emotion as stemming from a discrepancy between goals and reality. The conceptualization herein proposes that any conscious dealing with a matter starts with a specific emotion, namely surprise, which triggers cognitions which trigger emotions and so on.

Affects – as the "... superordinate category for valenced states ..." (Gross 1998) – are herein defined as evaluative statements of pleasure or displeasure in the course of system-environment-interactions which stimulate cognitive processes such as appraisal of potential risk, labelling, and attribution processes; drive actions; assess these actions; and may thereby induce learning and behavioural change. They have (1) an *emotive* short-term function of surprise, which signals (a) benefit vs. harm potentials (Lazarus 1991) and/or (b) success vs. problems with on-going plans (Bagozzi et al. 1999) both due to a schema discrepancy; (2) a *motivational* medium-term function, as on-going short-term emotions of the same valence constitute intrinsic vs. extrinsic motivation sensu Deci and Ryan (1985); (3) an *atmospheric* long-term function, as on-going medium-term emotions of the same valence constitute mood, lasting from hours to weeks, being no longer related to any specific entity and mainly subconscious or of peripheral consciousness (Pham 1998); and (4) a very-long-term *trait* function, which lets some purchasers appear more as recreational and others more as economic shoppers throughout different product categories (Bellenger and Korgaonkar 1980).

Man is viewed as a *hedonic man* seeking pleasure, avoiding pain and trying to manage his affects correspondingly. As always seeking pleasure by following one's impulses can cause future pain, our decisions have to be balanced between momentary *impulses* and future-oriented *impulse control* (Tice et al. 2001). Both the hedonic man hypothesis (Gendolla 2000) and the mood management hypothesis (Gross 1998) are empirically and theoretically well supported. They can be transferred to each other (Andrade 2005) as well as to the motivation construct (Bagozzi et al. 1999): If we pursue promotion goals, we seek pleasure; and if we pursue prevention goals, we aim to avoid pain (Aaker and Lee 2001). In terms of the Self Determination Theory (Deci and Ryan 1985), seeking pleasure is called *intrinsic* motivation and avoiding pain is called *extrinsic* motivation. Distinguishing intrinsic from extrinsic purchases contributes significantly to better understanding the nature of customer decisions (Kraigher-Krainer 2006).

It is important to note that intrinsic motivation requires a *can*-condition (i.e., *opportunities* such as access to relevant information or *abilities* like cognitive capacity or money) over and above the *want*-condition. If one of these is lacking, or if they vanish during a decision-making process, a formerly intrinsic motivation will become extrinsic. In the proposed loop-model this assumption can be well reasoned: A lacking can-condition during a process results in an accumulation of disappointing experiences (no advice, wrong information, time pressure, limited financial or cognitive capacities) and turns the motivation into extrinsic (remember that emotions not only signal benefit vs. harm potentials but success vs. problems with on-going plans as well).

2.3 Cognition

The cognitive system is conceptualized around the perceived-risk-concept, much in the original sense of Bauer's (1960) *risk of not anticipated* – hence schema-discrepant

– *unpleasant consequences*. Whereas the affect system tells us about momentary pleasure or pain, perceived risk brings the past-future-dimension and the fear of future loss of resources into play.

What is ultimately seen as a resource is again subjective and dynamic: Health, a partner, intelligence, personal assets, money, image and good relations, time, freedom, power, a job, a property and so on. However, as contrasted to Foa and Foa's (1976) resource theory of social exchange, *love*, for instance is not seen as a resource here, but rather as a pleasant state *arising from* resources such as attractiveness, charisma, prestige, money or the like. Finalizing actions are postponed and risk-reducing activities are likely to appear – note that in Fig. 1, the decision types three and four do not directly lead to exchange, but to risk reduction activities, instead.

Such activities include diligent preplanning and travelling to more distant stores, more systematic and effortful collection of information, asking or observing others, utilizing different kinds of guarantees, making trial purchases, renting instead of buying, altering purchase goals, bargaining and bluffing by showing not the slightest interest or pretending to have a purchase intention in order to obtain free consultation or to gain market transparency.

As soon as the judgment certainty has sufficiently increased and as long as the acquisition motivation still exceeds the now *expected* loss, a consequent exchange is likely which either results in the expected, or an unexpected loss of resources. However, risk-reduction attempts may not be successful or may even further increase perceived risk and therefore lead to the abandonment of a purchase intention or to a switch from intrinsic to extrinsic motivation. Furthermore, one possible action mentioned by Bauer (1960) is that we sometimes rush through a decision process with rapidity before having properly reduced risk.

2.4 Decision Types

Decision types are seen as prototypes rather than neatly sorted purchase behaviours. On the contrary, in a dynamic model one can assume, that during on-going loops, a mixture of more or all prototypes will be involved as motivation and risk perception go up and down. However, it is quite possible to assign most purchase tasks to one of these types due to the respective dominance of that type. As habit behaviour does not engage cognitive activity it is not a *decision* in a narrower sense and is thus dealt with earlier in this paper in the *Habit* section.

Impulsive behaviour (No. 1 in Fig. 1). Antecedents are pleasant schema discrepancies (SD^+) which *break routines* (Stern 1962) combined with low or no risk perception. Buying impulses do not necessarily lead to an impulse buy. Instead all the other decision types may emerge while checking on the on-going pleasantness and perceived risk. This can only be conceptualized within a dynamic model. Maybe, this is why it has been so difficult so far, to explain the difference between, for instance, *pure impulse buying* and *suggestion impulse buying* (Stern 1962):

Pure impulse buying remains in the intrinsic/no risk condition, whereas suggestion impulse buying starts with an impulse (a sudden urge, e.g.) and then develops to another decision type such as extensive behaviour.

Miserly behaviour (No. 2 in Fig. 1). Antecedents are negative schema discrepancies (SD^{-}) plus low risk perception. All behaviour resulting from negative surprise means dealing with a situation not because it is inherently pleasant, but instead in order to reach a separate future outcome – remember the hedonic man assumption. Many shopping duties for everyday items are assumed to be of this kind as everyday means boring and repetitive. The most efficient effort-minimizing strategy would, of course, be habitual behaviour. However, in the case of these habits being interrupted by an initial disappointment (product is out of stock, store is closed, price has increased, variants have increased confusingly, dissatisfaction with product, a family member objects to this particular brand, product is said to be harmful or unsafe, a bulky or heavy item has to be transported etc.) we are now forced to allocate some minimum effort to resolving exactly this problem at hand.

Vicarious behaviour (No. 3 in Fig. 1). Antecedent conditions are unpleasant schema discrepancies connected with high risk perception. Such a constellation inevitably causes a mood management dilemma: Diligently elaborating the problem means continuing momentary displeasure, whereas a quick and simple method (as applied to miserly decisions) would lead to the threat of unexpected loss and subsequent future displeasure. The foremost strategy to escape from such a dilemma is *trust*. Of course this can mean trust in well-known brands, expensive products, stores with a good reputation etc.; yet, the most reliable and immediate source for solving complex problems will always be other people (individuals and groups, family or peer-based, paid or unpaid, professional or personal) if these people exceed a critical level of credibility and competence.

Extensive behaviour (No. 4 in Fig. 1). Antecedents are positive schema discrepancies combined with high risk perception. If we enjoy a task, we have arrived at the state a hedonic man is aiming for and (unlike in the case of unpleasant tasks) time is not an issue, and we prefer to evoke mood-maintenance-tendencies rather than just getting the job done. However – recalling the can/want-condition – if we face major limitations the decision type might eventually turn into vicarious decision making or into abandoning or postponing the decision (see E_0 in Fig. 1).

2.5 Further Assumptions and Propositions on Decision Types

As mentioned before, the intensity of processing depends on the perceived risk. Cognition directly and stronger affects information processing. However, affect and cognition contribute independently of each other to explaining information processing so that the combined view better uncovers its whole nature. Generally speaking, the cognitive dimension explains if and why there is a need for information, whereas the affective dimension explains, how information is processed (if at all) and which types of sources are preferred.

2.6 Post Purchase Phase and Mixed Emotions

As mentioned before, we sometimes tend to rush through a decision process with rapidity before having reduced risk properly, putting up with all the possible consequences such a behaviour can generate, namely unexpected loss of resources and a subsequent loss of good mood. If this happens, a very likely reaction will be all sorts of mental operations, particularly why-questions and corresponding attribution processes.

Heider (1958) makes it quite plain that attribution processes arise from schema-discrepant experiences. Thus perceived responsibilities resulting from an outcome will depend on the motivation and abilities of the person involved (see can/want-condition) as well as on environmental factors such as task difficulty, intentions of others or simply luck. Whereas schema discrepancy first evokes a primary emotion of surprise, which is of low certainty (Lerner and Keltner 2000), during such mental operations different emotional qualities with higher certainty emerge, depending on the outcome of the respective attribution processes. If we had rushed through the process, we might experience guilt or regret, whereas if we had diligently processed all available information, we might feel rattled, afraid, sad or powerless. If we blame another person, rage or anger may emerge, blaming fate might make us feel depressed or jealous. Such emotions not only prompt us to question/update our schemata, they also give directions regarding their cause-effect-relationship. As a consequence, this conceptualization suggests that the particular form of dissatisfaction (e.g., with a brand) depends on negative disconfirmation plus the subjective outcome of corresponding attribution processes.

3 Implications

Moorthy's (1997) review on consumer information search concludes "... by emphasizing the need for a more careful study of the allocation of search effort across information sources ... The value of different information sources, and the difficulty of accessing them, are important issues in determining how customers search." This model attempts to bridge the gaps between prominent constructs and offers insights into exactly these consequent information and decision patterns by proposing five distinct behaviour types:

Habit behaviour is not the consequence of low involvement, but instead a separate behavioural pattern before any cognition (Katona 1953), thus before any involvement. The conceptualization herein suggests that involvement stems from two uncorrelated constructs, an emotional evaluation of task pleasantness, and a cognitive assessment of potential unexpected loss. Thus, involvement has four distinct states which allow for the assignment of four distinct consequent decision types. By clearing both dimensions of elements of the other, emotion turn out to be the instance that tells the perceiver what is (un)pleasant right now, whereas cognition appears to be the instance with a different logic or language: it takes care of the perceiver's resources and speaks the language of potential *future* loss. Emotions have no cognitive component (like the dominant conceptualization of attitudes would suggest) whereas cognitions have no evaluative component (as the two-component conceptualization of perceived risk would suggest).

These habits are presented as a powerful, indispensable and fundamental filter system. Thus man is neither busy, nor lazy (McGuire 1969), but rather pragmatic. This mechanism has to be conceptualized more prominently in behavioural models – especially nowadays where the consumer is confronted with thousands of marketing impulses each and every day. Furthermore, habitual behaviour is not a product-related single phenomenon but instead embedded in networks of other habits. Buying a *new* product may appear quite familiar if our habits regarding store, brand, or sales clerk are well established. For the same reason, habitual behaviour does not necessarily mean always purchasing the same brand. We can also get used to always picking out the cheapest brand within a category if we do not see other differences. Habits also shed a different light on prominent phenomena such as loyalty or variety seeking.

In recent years, considerable effort has been devoted to understanding the interaction between emotion and cognition. Unfortunately, "... the mechanisms linking affect to thinking and judgment remain incompletely understood." (Forgas 1995). Similarly, Gendolla (2000) states that "... an integrative theoretical framework making a small set of general predictions on how and when cognitive processes and hedonic motivation operate is still far from being available." and Bagozzi et al. (1999) note that we are "... only beginning to understand the role of emotions in marketing ..." However, here is an attempt to explain the working principle of emotions. Emotions break routines by signalling a deviation from the norm and by generating a primal reaction of surprise. They trigger attention and consciousness and then function as the contemporary evaluative *how-does-it-feel-right-now-instance*. The cognitive system, on the other hand, works as a kind of probability calculator that estimates the amount of resources at stake in future derived from past observations. If it identifies uncertainty, it forces the system to improve the judgmental certainty to come to a sound calculation before finalizing action.

As regarding decision types the proposed model not only offers a clear assignment of involvement patterns to decision types but also generates new decision types with high explanatory power: *vicarious* and *miserly behaviour*. The development of vicarious behaviour rests on observations in the insurance industry, where customers frequently report that they experience high risk and at the same time high unpleasantness when it comes to signing an insurance contract. Following the traditional models, high risk unconditionally leads to a diligent decision process and cognitive engagement, but customers do not show this. Rather they report to more or less rely on the recommendations of their agent or they sign contracts in blank, which again illustrates the explanatory power of the emotional dimension over and above a risk dimension. Miserly behaviour, on the other hand, illustrates that, yes, customers are cognitive misers under certain conditions, namely if the decision process is unpleasant, whereas they are not if intrinsically motivated. As regarding the on-going discussion on whether man is a better decision maker in a good or a bad mood (Cryder et al. 2008), this model indicates and explains why he makes better decisions when in a good mood. *Therapy shopping* doesn't seem to work well!

3.1 Managerial Insights

Involvement, perceived risk and decision types all had and still have an impact on the daily tasks of marketers and hopefully this paper will further contribute. Yet marketing has meanwhile significantly shifted its focus from what is termed *old* to a *new* marketing thinking. There are several reasons why managers might benefit from applying this model to their *new* tasks:

First, new marketing manages on-going relations instead of single transactions, a shift that calls for respective frameworks. This loop-model provides such an on-going perception process. It depicts pre-purchase, purchase, and post purchase phases at the same time, making it plain, that customers, of course, do not follow a different logic before and after a purchase decision: in the pre-purchase phase, a schema discrepancy stems either from a downward move of the actual state (*need recognition*), indicated by $E_1 < S_{(const.)}$; or from an upward move of the ideal state (*opportunity recognition*), indicated by $E_{1(const.)} < S$ (Brunner and Pomazal 1988). Similarly, the *counterfactual thinking* after an action shapes the *prefactual thinking* (Dhar and Wertenbroch 2000) of the upcoming action. This difference between a loop model and an SOR-model is as big as the difference between a customer database that is continuously updated with each touch point of the customer and his supplier and a database consisting of old data once recorded by a trainee.

Second, models for practitioners have to work with a limited set of variables (Mitchell 1999). The proposed one aims to offer exactly this: Prominent constructs are related to each other, influential theories from the social sciences are embedded, and the model takes developments in other disciplines such as system theory, or brain research into account and thus *reaches out* as suggested by Wells (1993). Compared to existing purchase models like Howard and Sheth's (1967) well recognized one, this one depicts customers' worlds with a fraction of the constructs and goes beyond single transactions at the same time. Of course, the model, like all models, still is a compromise between precision and practicability similar to a city map.

Third, another important improvement is the choice of a constructionist paradigm. This may contribute in encouraging managers to always look through the customer's and not their own eyes (Levitt 1960). Mixing up or equating customer perception with company perception is one if not the foremost source of shortcomings and failures in management: selling products instead of solutions, calling the customer irrational, if he does not buy, defining competition from the company's perspective, trying to understand markets from the boardroom etc.

Meyer and Schwager (2007), for instance, find in a study that only 8% of the customers describe their past experiences with companies as *superior*, yet 80% of the companies surveyed believe that the experience they have been providing is indeed superior. Peter Drucker has put a lot of emphasis on explaining the importance of the customer perspective. Even in 1954 (p. 36), he notes: "Marketing . . . is the whole business seen from the point of view of its final result, that is, from the customer's point of view." Correspondingly, "*Customer value* is market perceived quality adjusted for the relative price of your products." (Gale 1994) which compellingly leads to a constructive and relative conceptualization of customers' input/output *perceptions*. The comparison to competition (*market perceived*) is conceptualized via the schema construct – remember that schemata are internal representations of how the world functions, thus the direct as well as the indirect competitors contribute to what can be expected and what not. *Relative* to how others perform *a stable company performance* will be perceived as poor (SD^{-}); normal ($E_1 \approx S$) or superior (SD^{+}). This idea is not new, yet for the first time it is part of a bigger picture on decision making. Furthermore, relative may be differing strongly from a company-defined set of competitors: through the eyes of the customer this may be one company, a subjectively perceived evoked set of actual competitors, or even non-competitors, depending on the task. A simplified definition of who shapes the customer's reference points will very likely be misleading (Drucker 1964). As regarding Gale's notion on the *relative price*, later developments broaden the price term which will be addressed below.

Fourth and closely related to the last point, all constructs are conceptualized dynamically and the way customer perception *is*. In the course of time, reference points move up and down making the same performance disappointing one time and exciting another. Frequent price promotions, for instance, generate a positive surprise when first encountered, but shape the reference point at the same time. Sooner or later the promotion price will become the expected standard, and thus will not increase sales any longer but erode the brand. Similarly, promising more than the company can deliver will increase the reference point and inevitably lead to a disappointing experience of the customer. The emotion factor is equally dynamic: intrinsic motivation can easily become extrinsic if the customer is pressed for time, or accompanied by an extrinsically motivated friend, spouse or child, if a sales clerk intrudes, or the assortment is more than (s)he can handle. Correspondingly, Iyengar and Lepper (2000) conclude that "... although the provision of extensive choices may sometimes still be seen as initially desirable, it may also prove unexpectedly demotivating in the end." Together with a dynamic understanding of perceived risk the model – for the first time – enables the conceptualization of complex behavioural episodes such as a buying impulse that does not lead to an impulse buy or a purchase intention that is abandoned or postponed as well as an unintentional look around that eventually leads to a major expense.

Fifth, the conceptualization allows for a deeper insight into the independent and significant contribution of the motivational and cognitive dimensions to decision making. Motivation explains why we do something and there are two reasons why we deal with products and services: either the offer is inherently pleasant or the task has to be carried out to avoid even greater displeasure. If neither of the two fits, the perceiver is *amotivated* (Ryan and Deci 2000) and the stimulus disappears ($E_1 \rightarrow E_0$). It is not only well documented in literature, but also obvious that processing is closely connected to the motivation term. Perceived risk, on the other hand, has more directly been related to information processing in literature. Managers can now find out more precisely when and why the customer perceives a need for information and which kind – depending on the experienced fear of loss; or when information is likely to be unwanted. Finally, researchers have criticized the fact that risk reduction is seen too narrowly as information collection (e.g., Gemünden 1985); thus marketers have to be aware that in fact reducing risk entails a broad array of behaviours including information related, trust related, retreat related, or even deception related activities.

Sixth, combining perceived risk with resource theory offers an improved insight into what the customer exactly fears to lose and finally loses. A precise understanding of the subjective and dynamic interaction of perceived *risk* as a prefactual event for a certain business and perceived *loss* as a counterfactual event appear indispensable for communication management as well as for after sales service. The broadened expenses-term in new marketing thinking is conceptualized hereby. Particularly in business-to-business markets, it is often not the sales price that makes the crucial difference; rather is it the sum of acquisition costs, usage costs, ownership costs, maintenance costs, and disposal costs. Time as a resource appears to be particularly complex and the exact role of time in shopping trips is far from being resolved. Frequently, time is conceptualized as a limited resource or constraint (Sheth 1983; Suri and Monroe 2003; Garbarino and Edell 1997), but as well as an abstract form of monetary investment (Burnham et al. 2003; Schwartz 2004). “Time is a resource, as is money . . . If time were not a resource, the concept of being busy would not exist.” (Okada and Hoch 2004). From the hedonic-man position taken here it seems more appropriate, to primarily understand time as an inherent part of the end itself which sometimes is abstracted by us as some kind of resource, especially if we are pressed for time, or as some kind of investment if we are extrinsically motivated. This would lead to the managerial conclusion that the company is rewarded for saving customer’s time and effort only in the case of an extrinsic shopping tour, whereas time is more a positive outcome and thus kind of pleasant consumption that *has* to take time in the case of an intrinsic shopping tour – such as experiential shopping (Jones 1999). This again illustrates the importance of knowing the motivation that underlies a certain purchase or shopping trip, before investing in innovation, assortment, distribution, sales clerks, convenience, or POS-design.

Seventh, the proposed model might help managers in understanding and better utilizing the power of WOM and actively managing it. There is not much WOM on low-risk-products, particularly if purchased habitually or in a miserly way (Walker 1995). However, there is vital WOM on risky purchases, where extrinsically motivated customers serve as opinion seekers and intrinsically motivated customers as opinion leaders. Our recent research indicates that (1) in product categories where there is consensus on the high risk of the purchase, WOM is a factor which must not be overlooked; (2) if practically all customers are intrinsically motivated (e.g., holiday trips), WOM (face to face as well as web-based) will take the form of a vivid exchange of knowledge between customers-as-experts; (3) if one group of customers is intrinsically motivated whereas another group is extrinsically motivated (e.g., mobile phones) the former group will play an important role in the sense of opinion leaders and innovators/early adopters and the latter group will seek their advice and imitate them; (4) finally, if most or all customers are extrinsically motivated (e.g., insurances), no private opinion leaders (or informal consumer reports, as Bauer 1960 puts it) can be found by the opinion seekers. Here it is the company's task to not only diligently manage CtoC-communication but also implement experts in form of sales clerks, agents, surrogates, or the like. Furthermore, as company run informants lack credibility due to their suspected intention and partiality, trust as a facet of the company culture appears to become a key success factor in such industries. This indicates that the biggest loss of the recent financial crisis was, indeed, the loss of trust.

Eighth, further suggestions on communication policy are that ads play a more important role in confirming and stabilizing the habit behaviour of existing customers than suggested so far, whereas for the competition a major challenge is how to break up these habits by surprising people in a threefold way: (1) to receive their attention for a short period by well-established techniques such as humour, sex-appeal, unusual objects, fear appeals etc. – the easiest part of the job; (2) to keep attention and bridge to their offer – is much more difficult as customers identify mere ostentation very fast (Kroeber-Riel 1979); (3) if the supplier manages to convince the customer to give the product a try it is even more difficult to maintain the tension for several purchases so that the customer does not fall back into his former habit (e.g., by significantly impressing the customer with the first trials or by extending a promotion over a longer period).

Ninth and finally it has to be noted that involvement (Tyebjee 1979), shopping motivation (Tauber 1972) and risk perception (Conchar et al. 2004) have all been identified as recommendable constructs for market segmentation. These constructs are combined and linked and related to five behavioural types, each following a different purchase pattern thus requiring a different marketing strategy. Treacy and Wiersema (1995), for instance, propose three strategic *value disciplines*, which remarkably correspond with three of the decision types here: *operational excellence* with miserly behaviour; *product leadership* with extensive behaviour; and *customer intimacy* with vicarious behaviour. Yet, a lot of further research is needed, e.g., on a fourth excellence position a company can take, namely an experiential position – (sensu Holbrook and Hirschman 1982; Pine and Gilmore 1998) which might then turn out to correspond with impulsive behaviour.

3.2 Limitations and Future Research Directions

In this section, ideas for future research are presented which also shed a light on current limitations of the presented model. (1) The prominent conceptualization of habits herein calls for more research and a more central integration of habits in frameworks on decision making; (2) schemata are conceptualized as brain-models of a piece of reality: The *better* these models, the higher the individual's chance of survival and success. However, to a certain extent, they seem to be shaped by wishful thinking as well. More research is needed to better understand under which conditions this wishful thinking unfolds its influence on reality construction; (3) More research into the role of reference points in perception processes would be equally useful combining existing research findings: attribution processes are proposed to start with a schema discrepancy (Heider 1958). Estimates of physical objects are relative to personal values (Helson 1964) and social reference points (Asch 1956). Some interrupting event which *breaks routines* is proposed to be necessary to explain phenomena like cognitive effort (Garbarino and Edell 1997), impulsive behaviour (Stern 1962), interpersonal communication (Derbaix and Vanhamme 2003), or customer satisfaction (Hill 1986). Thus the interrupting function of emotions is well documented. However, in this paper it is specified that emotions do not directly intervene but arise from a schema discrepancy and then interrupt habits and guide our attention. More research on grasping all such perception phenomena relative to a reference point may connect social sciences with system theory; (4) the model proposes a malleable zone of tolerance for the comparison process $E_1 \approx S$. It would be helpful to better understand the function of this curve for (un)pleasant deviations, maybe by relating it to assimilation-contrast-approaches; (5) (dis)satisfaction appears as the result of not only expectancy disconfirmation, but rather of disconfirmation plus the subjective outcome of corresponding attribution processes. Combining attribution theory with the proposed model also sheds new light on the development of mixed emotions such as guilt, pride, helplessness, or anger in the course of post-purchase counterfactual thinking; an idea which might broaden satisfaction research; (6) more research on decision types appears fruitful: vicarious behaviour, for instance, raises numerous questions such as which kinds of agents (friends, experts, surrogates, opinion leaders, market mavens, e.g., Solomon 1986; Feick and Price 1987) the decision maker will prefer in which situation; miserly behaviour could be an important explanation for the choice-paradox as it is still open to question "… what factors influence consumers' tendency to overestimate their need for the flexibility offered by larger assortments …" (Chernev 2006); furthermore, much research is needed in the measurement of decision types. There are measures of consumers' tendency to buy spontaneously, behave hedonically or be loyalty prone, but not of the different decision types; (7) finally, this proposed decision type termed vicarious may stimulate urgently needed research on WOM over and above the well documented post-purchase, dissatisfaction triggered WOM (de Matos and Rossi 2008).

4 Conclusions

New marketing thinking shifts the focus from single transactions to on-going relationships and from company-delivered to customer-perceived value relative to reference points. Models are therefore needed that: depict relationships between supply and demand as a *dynamic* and *on-going* process; put *subjective customer value perception* into the centre; show the company relative to competition through the *eyes of customers*; broaden the *array of benefits and expenses* that determine customer decisions; provide insights into what kinds of marketing efforts are (un) wanted when, and thus will (not) generate value and finally put *WOM in a broader context* (Walker 1995).

The gap between an expected and an actual state has been proposed to trigger the first stage of decision making, namely the problem recognition (Brunner and Pomazal 1988) as well as the last stage, the post purchase satisfaction (Oliver 1980). Thus it is fair to assume that comparison to a standard is a general principle underlying the whole decision process. Furthermore, comparisons to standards and discrepancies are the foremost explanatory principle in the subjective well-being literature (Michalos 1985). As such, the model presented herein attempts to conceptualize a broad array of decision-related and satisfaction-related phenomena providing a bigger picture on customer satisfaction or even overall life-satisfaction of an individual manoeuvring through his environment. It claims to contribute to better understanding value creation in the purchase process as well as customers' pursuit of a valuable life in general.

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Emotions in Organisational Buying Behaviour: A Qualitative Empirical Investigation in Austria

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Abstract In the face of current value chain trends, e.g. outsourcing, global sourcing or the constitution of buying centres, B2B buyer-seller relationships are increasingly important. A frequently assumed paradigm of organizational buying behaviour is that professional buyers pursue corporate decisions based on rigorous cognitive analysis. Whereas consumer buying behaviour research suggests a strong influence of emotional aspects, the literature on organizational buying and supply chain management predominantly emphasizes the cognitive perspective of purchasing decisions. However it is questionable, whether purchasing representatives radically change their consumer behaviour in their business contexts. The majority of existing empirical (predominantly quantitative) surveys show limited explanatory power regarding emotional aspects within B2B purchasing and often can't be generalized. Altogether there are strong reasons to investigate the nature of emotions in the course of professional purchase decisions.

This paper intends to study the questions how far emotion is involved in the organizational buying and decision making process and which emotions can be identified. Subsequent to a thorough literature review we will apply a qualitative

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_11,

empirical research approach. The results will be duly substantiated into concrete managerial recommendations within the fields of sales and supplier management.

Keywords B2B • Emotion • Organizational buying decision • Purchasing decision

1 Introduction

Today's volatile and highly interconnected value chains strongly depend on well-performing interfaces between enterprises, in particular proficiently handled purchasing decisions. This applies in the vendor role towards the customer (marketing) and in the buyer role (supplier management). Thus, supply chain management (SCM) has become a core capability. Further, most companies concentrate on individual core competencies, thus contracting a rising number of other companies in the course of outsourcing decisions. Due to productivity reasons only few inventory buffers are held, enhancing the reliability and flexibility requirements towards suppliers. This is enforced through risen customer expectations regarding lead times and service level despite a various product range. Accordingly, value chain cooperation in B2B relationships (e.g. local or global supplier contracts or buying centres) is a critical success factor. Thus, the nature of B2B purchasing decisions is of major relevance for successful value chain management (VCM). This is also frequently stated in the literature (Yee et al. 2006, Luo et al. 2009).

There is strong indication that emotional factors play an important role in decision making in general (Lakomski and Evers 2010), and especially within B2C purchasing decisions (Andersen and Kumar 2006, Kraigher-Krainer 2007). However, in B2B-settings, existing supplier management approaches frequently assume that professional purchasing decisions rely on rational criteria and a cognitive chain of arguments (e.g., Ho et al. 2010). Contributions regarding the role of emotions in a professional vendor-customer relationship are found only occasionally. The majority of available surveys are based on a quantitative approach or unnatural lab settings (Kopelman et al. 2006) whose authors admit the limited explanatory power of these methods for understanding and measuring emotional processes (Erevelles 1998). Moreover, many findings are of limited generalizability due to the fact that only special aspects such as advertising (summarized by Poels and Dewitte 2006) or branding (e.g. Lynch 2004), or specific business areas such as stock markets (Myeong-Gu and Feldmann Barrett 2007) are analysed or they remain in the stage of a conceptual model which still awaits empirical confirmation (Andersen and Kumar 2006, Bagozzi 2006).

There is evidence from the literature that apart from emotional influences also other non-cognitive, "irrational" (Carter et al. 2007, p. 652) factors are influencing professional decision making. Such issues could for instance regard trust matters in supplier relationships (Fink and Kraus 2007), cultural influences (Carter et al. 2007), intuition (Patton 2003), the use of tacit knowledge (Giunipero et al. 1999), individually implied social responsibility issues (Park and Stoel 2005), subjectively differing decision heuristics (Krabuanrat and Phelps 1998) or impacts of asymmetric competitive value chain relationships (Pech and Slade 2003). For example Carter et al. (2007) have identified nine decision bias categories when investigating judgement and decision-making biases within supply management. Furthermore, preparatory narrative interviews with peer scholars outside the research team indicated that respondents in a survey might not clearly distinguish ‘true’ emotions from other aspects that on closer inspection are not emotionally motivated in a rigorous scientific sense of the term ‘emotion’.

Summarizing we assumed to be in a very early stage of research, seeking to understand in what regard emotions are impacting professional purchasing decisions, but yet without hypotheses and with scattered, partially contrary SCM-related literature: although the body of literature on emotions in general and concerning consumer purchasing decisions is huge, there are only few articles on behavioural aspects of B2B purchasing. To achieve a close fit between research questions (RQ) and research methodology, we did a “pre-empirical question development” (Punch 2005, p. 21) previous to selecting the research methods and deciding on what type of data to collect. An initially small bundle of questions was subjected to creative exploration in a discourse with peer scholars, yielding into an expanded question list that was subsequently “disentangled” (Punch 2005, p. 35) into three stable research questions:

RQ1: How far is emotion involved in the organizational buying- and decision making process?

RQ2: Which emotions can be identified as playing a dominant role?

RQ3: Is the ECID consumer decision model (Kraigher-Krainer 2007) also applicable for professional buying processes?

The selection of an applicable research approach depends on the access to the field (Flick 2006) and the type of data required to answer the RQs (Punch 2005, Patton 2002). Our concern was to explore the nature of emotional aspects of B2B purchasing including possibly emerging unexpected other ‘irrational’ aspects rather than testing predefined hypotheses or quantitatively measuring generic emotional categories with existing scales from psychology or related fields. For those reasons we chose a qualitative research approach that applied method, data source and researcher triangulation (Jonsen and Jehn 2009) to enhance result validity and to capture preferably rich and multifaceted insights from the field work.

Thus, the paper is structured as follows: Sect. 2 presents a thorough literature review and clarifies the conceptual assumptions for this investigation. Section 3 explains the methodological approach and the research design in more detail. Empirical findings are discussed in Sect. 4. Finally Sect. 5 reflects on achieved findings, managerial insights, possible limitations and future research needs.

2 Literature Review and Conceptual Substantiation

As a value chain context implies a consideration of several viewpoints on a buyer-seller interface, the literature review was conducted from different perspectives: methodological questions on decision making in general, purchasing decisions especially, sell-side motivated issues and buy-side-related matters. Thus, the following overview starts with rather generic articles and gradually enhances the degree of specialization. Section 2.1 outlines relevant contributions regarding the role of emotions in decision making. Section 2.2 considers emotions in marketing, *followed by a short substantation of the aforementioned EDID model* (Sect. 2.3) further particularizes the discussion about emotions in B2B settings, though not yet restricted to purchasing situations. A final specialization is achieved in Sect. 2.5 with the discussion of emotions in B2B purchasing and SCM.

2.1 Emotions in Decision Making

Emotions are a daily experience [. . .] inside and outside of work. They are both a response to events and situations that we encounter and a cause of our responses (Fox and Spector 2002, p. 167). Emotions are short-lived psychological reactions that respond to a specific situation, triggered by a certain event or used as a means to achieve an expected goal (Lazarus 1991, Kopelman et al. 2006). From a cognitive perspective, emotionality in managerial decisions is frequently considered to be the opposite of rationality or effectiveness and thus is regulated and “normalized” (Bagozzi 2006, Ashforth and Humphrey 1995, Ashforth and Kreiner 2002). However, if this were the truth, *firms could computerize much of [. . .] transactions and do away with most of the human element* (Bagozzi 2006, p. 453).

Decision making is supposed to be grounded first in the rational coordination of beliefs and desires and second in a way that abstracts from causal cognition or a purely symbolic logic, but additionally considers a supporting role of emotions (Lakomski and Evers 2010). In this regard recent behavioural and neuroscience research allows the assumption that rationality tends to break down in the absence of emotion. Especially Damasio illustrates the impossibility of decision making if emotions are deficient (see an outline in Bechara et al. 2003). In contrast to psychological or neurobiological researchers, who were the first to recognize the impact of emotions on decision processes (Kuzmina 2010), in a managerial context decisions are often supposed to depend on the expected utility. This becomes manifest in economic theories such as the *transaction cost* approach (Williamson 1981). Some authors (e.g. Ericson 2010) even today notice a dichotomy between rationality and emotion. The assumption of bounded rationality (Simon 1990, 1997) demands modifications compared to purely rational decision models for two reasons: first the availability of complete information and perfect foresight is unrealistic, restraining the calculation of expected values. Second the disposability of all thinkable behaviour patterns isn't granted. Simon (1990) therefore proposes using approximation approaches. Thus, the evaluation of alternatives has to include rational criteria and intuitive components, usually without being able to draw a clear boundary between both (Lakomski and Evers 2010). Since there are further "irrational" factors apart from emotions (Carter et al. 2007, p. 652) that might not be distinguished from each other precisely from deciders, a rigorous research approach has to consider such influences in developing its methodical design.

Wang and Ahmed (2003) continue this argument from a system methodological perspective: as soon as decisions are related to diffuse or ambiguous problems and can't be solved through the use of deterministic, linear solution patterns that rely on existing knowledge, behavioural aspects have to be considered. The unitary rational approach has to be supplemented by adding a more pluralistic, discussion-based way that also respects soft issues such as social processes or creative thinking. Interpretations of an issue may subjectively vary and the way of processing includes intentional action (for further discussion see e.g. Flood and Jackson 1991, Ho and Sculli 1994, Checkland and Scholes 1990). Besides the uncertainties of information and knowledge, the actual individualization trends and the reflexive interdependence in a value chain context are increasingly generating dilemma situations, further complicating decision processes (Höijer et al. 2006). Since the majority of academic contributions regarding emotions within decision processes is of a more universal nature and has investigated a professional purchasing decision context only rarely (Vanteddu et al. 2011), the current VCM literature and practice frequently use purely cognition based methods, tools and criteria for sourcing decision support – which is in fact guiding a manager to neglect definitely important issues, thus potentially lowering the decision quality.

2.2 *Emotions in Marketing*

Discussions about the role of emotions in marketing are ubiquitous. Wind (2006, p. 474) states that "the buying criteria of organizational buyers and consumers are multidimensional and involve relational and emotional characteristics, not only a consideration of feature, functionality, delivery, and price." Bagozzi et al. (1999, p. 202) describe the relevance of emotions for the entire marketing process: "they [emotions] influence information processing, mediate responses to persuasive appeals, measure the effects of marketing stimuli, initiate goal setting, enact goal-directed behaviours, and serve as ends and measures of consumer welfare." Numerous research papers of recent years not only in marketing but also in cognitive science, social psychology, artificial intelligence, neurosciences etc. have investigated and redefined the role of emotions in marketing (especially in advertising): Marci (2006) states that emotional processes play an important role in attention as well as processing and storage of information in memory. Many aspects of emotional processing and learning are processed unconsciously and run in brain regions, which are separated from the language centre. Consumers thus have difficulties bringing their emotional experiences into linguistic expression.

In contrast to a value chain context, the efficiency of developing emotional relationships in consumer marketing is widely accepted and well researched (as summarized e.g. by Laros and Steenkamp 2005). In particular Kraigher-Krainer (2007) developed a model explaining the interrelations between cognition and emotion in a consumer setting that is briefly presented below as it will be investigated further in the present research work.

2.3 *The ECID Model for Consumer Behaviour in Decision Making*

The ECID model (Kraigher-Krainer 2007) conceptualizes and empirically supports the pivotal role of emotions in consumers' purchase decisions. Basic ideas are: (1) habits play a more important role in decisions than discussed in the literature; (2) deciders are rather information avoiders than gatherers; (3) emotions are important for the question how much available information is filtered out by deciders. Particularly important are negative emotions, as they indicate unpleasant situations and evoke escape affinity rather than information-collection. However, as always seeking pleasure might cause future pain, decisions have to be balanced between momentary reward and future troubles (Tice et al. 2001). In terms of the self-determination theory (Deci and Ryan 1985), seeking pleasure is called *intrinsic* motivation and avoiding pain is called *extrinsic* motivation. Further analysing this model in a B2B-context is a substantial approach to investigate the transferability of insights from a consumer context to a professional value chain context.

2.3.1 Habit

As long as a given task meets expectations within a tolerance zone, this is the realm of *habit*. In daily decisions, networks of routines regarding brands, people, products and prices, ways of cuing price cuts, processing modes, ways of using a product, job-related rituals, process descriptions, information source habits etc. are complexly intertwined thus mutually stabilizing and making each other resistant to change. Out of this iceberg arise momentary expectation disconfirmations which catch attention, yet relying on the invisible bulk of internalized routines.

2.3.2 Emotion and Motivation

It is the unusual entity, the deviation from the subjective norm, which interrupts habits. The resulting schema discrepancy evokes an emotional reaction of surprise

(Vanhamme 2000) which is experienced as either positive and pleasant – signalling success and further pleasure – or negative and disappointing – signalling failure and potential threats. Intrinsic motivation requires a *want*-condition (a pleasant task) and a *can*-condition (i.e. *opportunities* such as access to relevant information or *abilities* like cognitive capacity or money). If one of these is lacking, or if they vanish during a decision process, a formerly intrinsic motivation will become extrinsic – e.g., a decision task which becomes too complex during its progress.

2.3.3 Cognition

The cognitive system is conceptualized around Bauer's (1960) perceived risk concept of unexpected, unpleasant consequences of a decision. Whereas the affect system tells about momentary pleasure or pain, perceived risk brings the past-future-dimension and the fear of future loss of resources and corresponding negative emotions into play. Under the perception of risk, decisions are postponed and risk-reducing activities are likely to appear. Such activities include diligent preplanning, more effortful collection of information, asking or observing others, trial purchases, assessing samples, renting instead of buying, bargaining and bluffing, pretending purchase intention to obtain free consultation or market transparency.

2.3.4 Resulting Decision Types

The two dimensions motivation and perceived risk result in four decision types (Table 1).

Impulsive behaviour results from an urge to attain immediate reward by means of a nice person, a fascinating product, a good bargain or another immediate pleasure or a prerequisite to pleasure. *Miserly behaviour* stems from an uninteresting riskless problem and provokes getting rid of it as soon as possible, remediating the negative perturbation with a minimum of effort. *Vicarious behaviour* means not solving the problem but delegating the decision to credible others, relying on their recommendations to overcome the unpleasant, complex decision. *Extensive behaviour* is the thorough accumulation and analysis of distributed, heterogeneous information, comparable with the traditional idea of the 'economic man'.

Generally speaking, the cognitive dimension explains if and why there is an information need and which information is requested. In contrast the affective dimension explains how information is processed and which sources are preferred.

Table 1 Four decision types arising from motivation and perceived risk

		Perceived Risk	
		Low	High
Motivation	Intrinsic	Impulsive	Extensive
	Extrinsic	Miserly	Vicarious

2.4 Emotions in B2B Operations

In contrast to consumer behaviour, in B2B settings there is scepticism about the impact of emotional approaches on marketing success and business performance (Lynch and Chernatony 2007). The impact of emotional issues on business operations has been selectively acknowledged e.g. associated with team projects (Peslak 2005), concerning management (Brotheridge and Lee 2008) or in specific fields, such as public relations (Yeomans 2007). Čater and Čater (2009), who investigate customer loyalty in the B2B service sector even conclude that emotion influences business relationships more than ratio. In many conceptual models, emotions are hypothesized as playing a role in initiating, developing and sustenance of relations (e.g. Andersen and Kumar 2006). Altogether, the evidence for assuming a relevant impact of emotions on purchasing is strong, but scarcely analysed in particular.

When it comes to negotiation and sales processes, practitioners are irresolute and scientific research is fragmentary. A body of scholars argues that negotiations are predominantly influenced by cognition (Raiffa 1982, Neale and Bazerman 1991, Olekalns and Smith 2005). In managerial practice, purchasers also claim to be motivated by intellect alone, whereas sales practitioners assume that their counterparts run on both, reason and emotions (Reichard 1985). There is still limited research in the field of emotions in industrial marketing. Recent work on the use of affect in personal selling is mostly related to the seller's point of view, focusing on sales call anxiety (Belschak et al. 2006), shame/embarrassment (Verbeke and Bagozzi 2002), listening skills (Comer and Drollinger 1999) or optimism (Schulman 1999) and positive mood states (George 1998). Interpersonal effects of emotions (van Kleef et al. 2004) and the buyer's perspective – how industrial purchasers perceive and handle emotions – are not empirically substantiated.

2.5 Emotions in B2B Purchasing and Value Chain Management

B2B purchasing decisions, especially supplier selection, are usually subjected to purely cognitive decision criteria (in particular cost, quality, delivery reliability and flexibility; for a recent literature review see Vanteddu et al. 2011). Professional purchasing and supplier management procedures usually involve several individuals, e.g. a negotiation team. Thus, emotion research can't be limited to an individual level but has to include an organizational view (Tran 1998). Only few publications cover the issue of emotions in buyer-seller relationships from a value chain or buy-side point of view. In a VCM-context, e.g. van Hook et al. (2002) emphasize emotional capabilities as a necessary supplement to technical capabilities. They however treat, like many other VCM-related articles, emotion at a rather generic level, without specific focus on buyer-seller relations or purchasing decisions. A similar abstraction level is found in Wilding (1999), who proposes more efficiently leveraging soft skills to obtain time savings and agility improvements.

Contributions that take a closer look at purchasing decisions show a diverse focus. Giunipero et al. (1999) observed a fair balance between the use of formal data and tacit knowledge (implying behaviour-related aspects) in a survey with purchasing managers and state a clear relationship to the concept of bounded rationality. However, there is no explicit discussion regarding the role of emotions in the course of purchasing decisions. Another example is presented in Park and Stoel (2005), who investigate social responsibility in buying decisions. Though cognitive and non-cognitive determinates of ethical decisions are analysed, at most analogical conclusions can be drawn regarding the nature of B2B purchasing.

Another relevant field is outsourcing. Webb and Laborde (2005) claim outsourcing to be an emotional decision, though without empiric evidence and not clearly distinguishing the initial make-or-buy decision from the following vendor decision. An empiric approach is presented by Donada and Nogatchewsky (2009) who study the issue of supplier switching in the hotel industry. They assume a clear influence of emotions additionally to rational issues (e.g. switching cost), however restricted to the hotel sector, thus limiting the ability to generalize results.

Summarizing, the conducted literature review has confirmed constitutive assumptions: emotional influences on professional purchasing decisions have not yet been intensively investigated from a buy-side perspective, although there is notable evidence that such decisions don't fully rely on cognitive analysis. Existing conceptual and empirical research neither exhibits a sufficient explanatory power nor a satisfactory generalization capability. Emotions are complex, possibly ambiguous constructs that have been intensively investigated by psychologists, but have barely been a subject among economists (Loewenstein 2000). Thus, there is strong reason to investigate the impact of emotions on B2B purchasing decisions.

The fact that existing emotion lists and quantitative scales to measure emotions are diverse (Laros and Steenkamp 2005), further strengthened our decision to use an explorative methodological approach at this stage of the research progression.

3 Methodology and Empirical Research Design

In line with Dawson et al. (2006) we believe that the field of value chain management should be researched using an integrated methodical pluralism of both, qualitative and qualitative approaches. At best, the use of variable methods can in principle serve the same question, focusing on different aspects during different stages of the overall research path, thus finally leading to converging views. According to the aforementioned early stage of the present research and being guided from our pre-empirically developed research questions (Punch 2005), that are of clearly explorative nature, strongly emphasizing on 'how'-questions rather than intending to test hypotheses or to investigate predefined categories, we first decided to exclude lab-situations. Since the data we needed to look at in answering our questions was scarcely formalized, compatible methods (Punch 2005, Flick 2006, Patton 2002) had to be selected. The approach needed to be open towards unexpectedly emerging issues beyond the scope of initial presumptions. Further guidance came from a framework of research paradigms (Meredith et al. 1989). Here we excluded the use of artificial information and decided on looking at people's perceptions of reality (choosing non-directive types of interviews and group discussion), since a direct access to reality observation during actual purchasing decisions is impossible in our context. Also the novel nature of this study indicates a field-based approach (Meredith 1998), which was conducted with methodological rigor (Carter et al. 2008). Altogether, our particular focus on how organizations work, how people make decisions including emotional aspects can't be sufficiently investigated with quantitative methods alone, when seeking for a holistic in-depth understanding of the given social reality (Patton 2002) – especially when the investigated issue is explorative-descriptive in nature (Kidd 2004). An established methodical approach to conduct qualitative content analysis was introduced by Mayring (2008). As this proceeding notably suits the circumstances of the present investigation, it was particularly respected in our methodological progression.

3.1 Methodological Mix and Triangulation

In order to achieve realistic and thorough insights and to enhance the validity through reciprocal verification, this study applies different kinds of triangulation (see Denzin 1978 or Jick 1979 for an overview of the origin, emergence and nature of triangulation; for further discussion of the eligible uses and forms of qualitative inquiry, in particular triangulation see Jonsen and Jehn 2009, Delattre et al. 2009, Denzin 2001; in an SCM context see Singhal et al. 2008):

- *Data triangulation:* the use of a variety of sources, deriving the data from face to face interviews with the main target group and from focus groups including participative observation. Interviewing, observation, document analysis and content analysis of the data derived from the fieldwork were combined.
- *Investigator triangulation:* the involvement of different researchers or evaluators. This study was done by a multidisciplinary team, including researchers from economic sciences (in particular sales and marketing, logistics and SCM), sociology and psychology, bringing in their qualifications, experiences and perspectives. To achieve inter-subjectivity all data have been analysed by each researcher, followed by an elaborate joint interpretation and calibration.
- *Methodological triangulation:* this research used multiple methods to study a single problem to widen the insights and findings and, as far as possible, to exclude methodological artefacts (Jick 1979). The qualitative methods of personal, individual interviews, expert interviews and focus groups with two different target groups (sell-side/buy-side) have been combined.

The data processing was supported with the software MAXQDA (Kuckartz 2007, Flick 2006; for further details regarding the use of such tools – in particular MAXQDA – see e.g. Corbin and Strauss 2008, reviewed in Moore 2009).

3.2 *Empirical Research Design*

The study design was three-tiered. First, narrative expert interviews were conducted to ensure a high quality set-up with a broad perspective and yet conceptual clarity (Punch 2005). The subsequent core fieldworks took place in the form of, second, cross-industry personal interviews and, third, focus groups.

3.2.1 Data Collection, Research Setting and Content of Observations

The data collection included three steps. At first, three experts, who exhibited a substantive field experience in (1) sales, (2) SCM and purchasing, and (3) psychology were interviewed concerning their mind-set, appraisal and ideas regarding the investigation of emotional influences on professional purchasing decisions in a non-directive setting. The interviewees were selected through the use of personal references of peers and according to their excellent vocational education and extensive practical experience in relevant industry positions. Second, a guided interview design was developed, discussed and pretested with research peers based on the findings from step one and on our literature review. Hence, ten in-depth face-to-face interviews with key purchasing deciders (heads of sales/purchasing departments) were conducted. Core issues during these interviews were:

- the individual interviewee's definition of a B2B purchase situation
- possible types of professional purchasing decisions (including examples)
- purchasing decisions within the range from habitual to exceptional purchasing
- decision strategies, principles and procedures
- consequences that were to be expected subsequent to a decision
- context factors, e.g. incomplete information, lack of time, complexity etc.

Initially, the intention to investigate the role of emotions was totally hidden to obtain an unbiased impression regarding cognitive and affective aspects and their mutual weighting. Step by step, indirect questions were appended (e.g. asking for examples and asking how a respondent had thought or felt in a reported situation that implied emotional aspects). Finally emotions were explicitly asked for.

In the third and last step, two focus groups a six participants were conducted (sales and purchasing managers separately) with a new participant sample. This was done to discover collective orientations and to ensure that differences compared to the interviews or literature findings would result from the research subject but not from the used method (Jick 1979). To avoid biases, the group discussions were moderated by an external institute without knowing the previous findings.

3.2.2 Sample Determination and Selection of Respondents

The participants were selected using a purposeful sampling strategy (Yin 2003). First a 'long list' of possible Austrian company representatives was compiled from the web, the mercantile directory, known sales and purchasing initiatives, peer contacts, congress participant lists and membership lists of a noted Austrian SCM association. Respondents were invited to participate via phone, indistinctly indicating the intention to investigate purchasing situations without explicit mentioning emotional issues. Next, a participant 'short list' was extracted together with peer scholars. Selection criteria were: considerable B2B purchasing/sales experience and capacious decision responsibility (e.g. legal responsibility, purchasing or sales volume). Due to feasibility reasons, the regional specification was restricted to candidates who were currently working in Austria. To maximize information-richness, the selection was done with regard to a best possible plurality regarding industry sector, product range, purchasing volume, company size and formal constitution. Main industry sectors involved were automotive, electronics, glass, paper, mechanical engineering, metal ware, automation and environmental engineering. Most companies were middle-class and medium-sized.

3.2.3 Data Analysis

The data analysis used two main constituents: first qualitative content analysis based on audio/video records and written transcriptions from the interviews and groups and second a computer assisted qualitative data analysis (MAXQDA).

4 Empirical Findings and Discussion

This section presents the findings of the fieldwork study. In terms of investigator triangulation data analysis and interpretation were performed jointly. Individual elaboration was iteratively alternated with joint discussion.

4.1 RQ 1 – the Role of Emotions in Organizational Buying Decisions

Overall attested tendencies comprise the following rational decision drivers that are congruent with those mentioned in the literature (e.g. Ho et al. 2010):

- *financial aspects*: price, follow up costs, terms of payment
- *product issues*: technical attributes, product quality/service, supply guarantee
- *order characteristics*: purchase order volume and value, warranty regulations

- *logistic attributes*: delivery time, delivery capacity and reliability, adherence to schedules, service level, replenishment lead time, supplier flexibility
- *supplier issues*: supplier performance, competence, references, transparency
- *coordinative attributes*: internal processes and specifications

Named indicators for emotional issues were “feeling of being in a good partnership”, “feel to be in good hands”, or “feeling the supplier is doing something for me”. Trustfulness, reliability, openness, commitment, partnership, and contact behaviour were reported to be crucial. Most respondents confirmed that emotions play a role in the buyer-seller encounter (“feelings are always vital [. . .] not only the rational arguments [. . .] also the feeling”). However, the hard facts are regarded as leading in the decision process. Emotions seem to play a shifting role during the buying process and are said to be neglected in the final decisive stage (“by no means are emotions pivotal for the decision [.], however feelings may influence the way towards the decision”; “emotions have no influence when it comes to decision, but [. . .] earlier”; “emotions [.] are important in the supplier pre-selection”).

Purchasing managers try to exclude emotions during supplier selection, but admit, they can’t be neutralized (“it’s people that are working, and people are triggered by emotions [.] which may have little relation to the factual arguments”; “emotions should be eliminated”; “primary goal is to exclude emotions”). Some statements are ambiguous, claiming emotions to be avoided and at the same time describing “sympathy” as influential. There are positive associations with emotions such as a “feeling for a supplier” or a “gut instinct”. According to a majority of respondents, such intuition originates from long-term experience (“if something seems to be perfect, but your intuition says ‘be careful’, you should be careful, because mostly it is an appropriate interpretation [. . .] related to experience”).

An interesting observation was that the used idioms often had an emotional colouring also during passages that claimed to be cognitive. Frequently non-verbal dialogue constituents indicated emotional traces contradictory to the reported rational arguments, thus indicating a possibly low social desirability of emotions in a B2B context. This is affirmed by the fact that some respondents excused themselves for following their (irrational) “intuition” using exculpatory arguments like “experience” or “know-how” as the determining (rational) reason.

In regard to the stated cognition-emotion balance, a sound information acquisition and diligent preparation were assumed as self-evident for sourcing decisions. Environmental factors such as complexity, incomplete information or expected risks were faced with initially rational and next emotional arguments. Interviewees and group participants were disputed concerning the emotional constituents of such situations: some respondents emphasized anxiety to avoid emotions, others considered affective impetus as constitutional – at times utile, at times unsettling.

In long-term and strategic supplier relations, feelings gain a higher significance (“if we are concerned about soft facts [. . .], we would rather pay a cent more”), showing a broad range of emotions (“we are all human beings related to emotions”; “purchasers also do have emotions”; “a positive atmosphere is extremely important”). The respondents perceive emotions to be a trigger for the establishment and maintenance of relations, assuming personal contact as vital. This is in line with Andersen and Kumar (2006), who state that negative emotions will increase transaction costs as well as problems to maintain and repair a buyer-seller relationship. The respondents further attest impacts of quality and atmosphere of business relations on business success, service quality and price. Nevertheless rational issues must be considered ("the human component [. . .] helps concerning the realization of business"; "the more you are able to relate with each other, the easier is business"). Respondents again pointed out a cognition-emotion balance ("friendly with humans while hard in affairs"). The human component was concretized as sympathy/antipathy, friendship, joy, happiness, excitement or pride, but also anger, fear and tension. Interestingly, also formalized IT-supported buying situations (e.g. e-auctions) were reported to activate strong emotions among suppliers ("breaking relationships"; "abandoning all personal ties").

Altogether, to answer RQ 1, it can be stated that the empirical results strongly support the assumption that emotions are an important determinant for professional buying decisions, against the majority of supplier management literature.

4.2 RQ 2 – Emotions that Play a Dominant Role

The observed variety of emotions was broad. The data in particular yields the following *positively* perceived issues as more dominant than others:

- *feeling of personal success and motivation:* experienced success results in pleasure, enjoyment and motivation, implicating corporate and personal success. Beneficial are decision freedom, responsibility and long-term orientation
- *positive excitement, thrill, fun, joy and pleasure* were prevalently mentioned
- *pride* ("if you [. . .] show a saving of at least 100,000 EUR [. . .], this is a good feeling" or "I become 'emotional', if I complete a good deal"). This supports the transferability of existing research regarding the central force of pride as a positive social emotion in B2B marketing (Lewis, 2000, Bagozzi, 2006)

The following *negative* emotion bundles have been indicated most frequently:

- *anger, annoyance, negative excitement and tension*, related to business partnerships, negotiations or company-internal relations. A further occasion for anger, fear and tension was seen in case of wrong decisions, especially if associated with high risk or uncertainty. Purchasers mention fear, harassment or threat
- *power* was mentioned in the context of business partnerships and negotiations, above all concerning the issue of pressure on price and price reductions
- finally also *nervousness*, *mistrust*, *fear* or *tentativeness* were stated often

Altogether, to answer RQ 2, particular bundles of positive and negative emotions could be extracted as influential. In a future research step, existing scales for the measurement of emotions could be transferred from e.g. psychology and where necessary be adapted to a VCM context, in particular clearly distinguishing individual from organizational influences and sorting out purely emotional issues from other irrational aspects (trust, intuition or the stated "vividness" of relationships).

4.3 RQ 3 – Transferability of the ECID Model from B2C to B2B

Habitual behaviour: most respondents reported routine behaviour, in particular standard processes such as low price, low value or 'C-type' orders. Big companies show a higher tendency for routines due to lots of standardized conditions, responsibilities and processes, whereas SMEs seem more context-driven and less reliant on routines. Instances for *breaking of routines* are problems with the supplier, sudden demand fluctuations or the integration of new suppliers and technologies.

Motivation: purchasers report that they like or even love their jobs, though there are tasks they prefer to others. Instances of *intrinsic motivation* are pleasure and enjoyment on experiencing success, efforts worth the time invested, tasks that are honoured by the organization or the superior and challenging tasks – unless they become too complex or impossible to handle. Typical instances of negative emotions and *extrinsic motivation* are the termination of contracts, problems or breaks of supplier relations, unrealistic time frames or excessive complexity.

Risk perception arises from several factors, predominantly supply risk. On the personal side, purchasers report job loss and negative career influences. Also *risk reduction strategies* are in place: the higher the risk the more people are involved to reduce corporate and personal risk. For example trust in the supplier, reputation and brand image are mentioned to be risk-reducing.

Purchase decision types: most respondents tend to deny *impulsive behaviour* in B2B purchasing decisions. Yet contrary evidence appears from reported statements ("sometimes you have to act spontaneously, if it is pressing, urgent – but [. . .] it should not be like this"). Further, the thrill of the hunt is frequently mentioned as a typical case of impulsive decision making. Respondents also report an *indirect impulse phenomenon* where technicians become affected by a certain technology, thus being highly motivated to act as an internal sales person.

Asked for cases of *miserly decision making*, respondents mention the sourcing of monotonous or "stupid" parts such as C-parts, after sales service or repair.

Vicarious decision making: the buyers find examples such as relying on the opinion of experts if information is difficult to get or ambivalent or if the purchaser feels overstretched or experiences a lack of know-how. Seeking the advice of colleagues and collective decision making are common. On the sales-side, it is again the importance of a strong, unique reputation, relationships and trust that counts in the B2B business and makes up the main difference to B2C decisions.

Extensive decisions: all samples agree on the importance of extensive decision making as the norm when a decision is long-run, strategic or of high volume/risk.

4.4 Observations and Appraisals Beyond the Research Questions

Due to the explorative nature of this research several further observations, reported perceptions and hints with significant impact on sourcing decisions arose:

- emotional issues must not only be investigated in a mutual dependency of individual and organizational constituents (Tran 1998), but are also influenced from reciprocal relational issues on individual and corporate collaboration level
- the results indicated emotional shifts during different purchasing process stages
- there is an unclear differentiation between three (maybe on further inspection more) types and perspectives of purchasing decisions: (1) singular simple, fast and low-risk discrete transactions, (2) singular complex and high-risk, thus longer-lasting and extensive but yet discrete transactions and (3) continuously developing relations due to repeated purchasing and eventually further collaboration (joint development etc.). In particular the third (3) is interfering with (1) and (2) and is tied to a bundle of motivations (efficiency, quality, mutual build-up of tacit knowledge and trust, joint investment, entry/exit barriers etc.)
- there was clear evidence that respondents used decision heuristics given incomplete information, time pressure, high risk or opportunism. The cognitive, emotional and other irrational impacts that occur in this regard and that might possibly influence behavioural patterns would have to investigated further
- from interviews and group discussions it became clear that personality issues (e.g. risk affinity) might be influential. Thus it would have to be analysed, whether employees in purchasing and/or sales positions are close to an average personality profile of employees (or even humans) in general or whether B2B collaboration preferably requires/attracts a certain personality type – again influencing the course of professional sourcing decisions and emotional impacts
- reported emotions were anger, stress or pressure. Since psychology assumes behaviour changes (Schaufeli and Enzmann 1998) when individuals perceive stress, are criticized or run scared, such effects on B2B purchasing decisions and their emotional aspects would have to be respectively investigated
- as we noticed frequent contradictions between enunciated statements, coevally used verbal expression and observed non-verbal behaviour, we suppose respective biases in purely interrogative research. This most likely results from social acceptability issues (distortive influences from other survey participants and investigators) and from differences between perceived or reported behaviour and (partially unconscious) actual behaviour; whereas the first could partially be excluded through anonymous questionnaires (web, email), the second would require direct observation e.g. in a case study (cp. Punch 2005, Flick 2006)
- purchasing and sales managers had a contrary opinion regarding the degree of freedom of purchasing deciders: whereas vendors evaluate their autonomy to be high, sellers assess it as low due to the fact that purchasing decisions are often predetermined through technical agreements with other departments, little

choice among alternative providers or a pre-set top management directive. But also cultural determinants of this freedoms where frequently mentioned in our survey. An effect that might be worth looking at is our impression that this differing mutual perception of buyer freedom might rise emotions itself – possibly because in this case parties do not respect themselves as equipollent with each other. Since the sales group had more capital equipment good representatives compared to the participants from purchasing, this observation could depend on the type of purchased goods (capital equipment versus commodities) but could also be a universal phenomenon (e.g. if determined culturally). Further research designs will have to investigate generic issues like culture and also will have to carefully respect dependencies from characteristics of purchased goods. This also applies for other issues beyond autonomy and for other goods characteristics, e.g. value, volume, production hold-up probability, inventory risk etc.
- future research has to develop means to distinguish operative from strategic purchasing despite practical fuzziness. Whereas VCM-theory clearly differentiates (Pressey et al. 2009), our findings show managerial vagueness
- though the literature usually doesn't consider firm size as a relevant attribute in SCM research (cp. the review in Arend and Wisner 2005), our findings showed that issues like 'gut instinct' might be more dominant in small enterprises

Since the interviews and group discussions yielded into suchlike rich explorative evidence, we took a second look into the three narrative expert interviews ((1) sales, (2) SCM/purchasing and (3) psychology) with the following results:

- emotional influences were even assumed to have a higher impact on B2B purchasing decisions from the experts' view than from regular survey participants'
- the experts state a distinct anxiety in companies to objectify decisions through the use of rational criteria and assume deciders to respectively project their irrational impulses into cognitive rating means – consciously and unconsciously
- the experts emphasized the importance to capture the context of buying or supplier decisions – an issue that again depends on rational and irrational impacts
- if a rational comparison of purchasing options is impossible or evaluated decision alternatives are equal, emotions come into place to guide the final decision

Altogether the empiric data yielded rich and multifaceted evidence, indicating plenty of issues for further research.

5 Conclusions

The findings of our survey imply conclusions for further research and managerial practice. Due to the explorative and triangular approach we gained deeper insight into the buyer-seller-relationship in the B2B area and the influences that emotions have on organizational purchasing. In contrast to current scepticism in the value chain literature regarding the impact of non-cognitive influences in a professional context, we confirmed that emotions play an essential role in organizational buying processes. Since the operationalization of emotional constructs by survey respondents was sometimes contradictory to scientific definitions or ambiguous, the used qualitative design has proven to be applicable. We identified a wide variety of emotions to be present during purchasing decisions and were able to name further irrational factors, e.g. trust, intuition, implicit knowledge or company culture.

In contrast to the economic and VCM-related literature that usually claims professional supplier selection and purchasing decisions to rely on purely rational reasoning, positive and negative emotions have a vital impact on organizational buying processes, although the opinion of the survey participants was that rational aspects usually are considered antecedent to subjective factors. Although several respondents mention their efforts to exclude affective impulses in a professional context, we identified *happiness*, *joy, excitement*, *anger*, *fear* and *tension* in most decisions. Among the positive emotions, the happiness about a good deal and the excitement about complex, challenging projects were dominant. *Anger*, *jealousy* and *negative tension* prevailed when role conflicts, ignorance of the buyer's role and high-risk projects were discussed. *Fear* was admitted to be an emotion in cases of failures. Interestingly, the role of emotions seems to fluctuate: we found indication that deciders are increasingly relying on emotional aspects in long-term supplier relationships or in the absence of rational calculability and predictability.

Further, the findings indicate that the ECID model, preliminary developed for consumer markets, might be transferable to a B2B context with adjustments, since evidence for all contained decision types was found in the empirical data. This might also apply for other B2C-related approaches that weren't investigated here.

5.1 Managerial Insights

In the literature B2B purchasing decisions, in particular supplier selection, are almost ever treated using cognitive criteria only (Vanteddu et al. 2011). Contrarily (and in line with research outside VCM that has been neglected so far regarding purchasing issues) we conclude for procurement and VCM practice that this might be short-sighted. Purchasing and sales managers are affected by emotions and they are aware of that. Future method development and practical routines, for example, for supplier evaluation should include this currently neglected (or denied) concern.

For marketing practitioners we conclude that the presence of emotional aspects in the buyer-seller relationship has affirmative dimensions and new consequences. We learn that using emotional appeals in B2B marketing communication could supplement rational arguments well. For organizational selling, the findings show that emotional approaches and addressing possibly fluctuating feelings during the selling process can increase sales success and improve the relationship between buyer and seller. The fact that positive emotions like thrill and excitement occur especially during complex and challenging buying decisions may lead us to the conclusion that sales people should not ‘oversimplify’ tasks nor should they try to ‘take all the burden from the buyer’s shoulders’ to release them from parts of their work. This might turn positive emotions into ‘boring’ routine procedures and the buyer feels ‘ignored’ and less ‘valuable’. Designing a negotiation or purchasing process as a fascinating and challenging but never overburdening and threatening experience for the professional customer could be a suitable approach. Further, passing over the buyer and directly approaching the technical demand carrier (e.g. a production engineer) can lead to negative emotions like anger and disappointment. Sales representatives should therefore carefully communicate and should be sensitive about the buyers’ information needs, jealousies or conflicts among different parties at the buyers’ side. Since buyers state a strong reliance on their experience and intuition, both related with pride, sales managers could make use of this feeling by recognizing their counterparts’ experience and intuition.

Both, sales and supplier management, should put stronger emphasis on subjective, ‘fuzzy’ factors such as atmosphere, context, trust or tacit knowledge – most of them looked at with suspicion within traditional management styles. In the face of growing work pressure, velocity and overcharge, companies can potentially exploit but also must eventually hazard the consequences of rapid and thus predominantly emotional, barely controllable decision taking – a novel challenge for respective analysis and decision support methods and criteria. Future managerial tasks might require a lesser and more focused extent of exhaustive rational analysis in favour of a fluctuating balance with more holistic or fuzzy determinants.

5.2 Limitations and Directions for Further Research

The researchers attempted to apply a robust mix of methods to yield sound and reliable results. However, caution has to be exercised not to overgeneralize the findings. The study was conducted among Austrian managers, thus it cannot be concluded that the findings can be transferred to different regional and cultural environments. The ECID-model was confirmed in principle. However, it might be useful to continue investigations in this field and to reappraise these findings with other models and research methods, for different product categories and in different business types in a large-scale investigation. Moreover, we observed several irrational aspects, for instance trust, to be a phenomenon that might be related to emotions as well. An in-depth examination of appropriate data as well as a fundamental reappraisal of existing literature will be necessary to gain clear insight into this coherence. The interference between individual and organizational decision making should be investigated further, same as the differentiation between singular discrete transactions and continuously evolving relationships. Since we observed the use of decision heuristics, a similar research topic might evolves as with the issue of emotional aspects: determinants of decision making are intensively discussed outside VCM but might be underrepresented in the VCM-literature. A transferability of universal coherences might be applicable but also could provoke complicacies.

Altogether the findings of this survey have laid a solid foundation for hypothesis building regarding emotional influences on B2B purchasing decisions and the subsequent inclusion of quantitative measures in the forthcoming research steps.

Acknowledgments The authors wish to thank the two anonymous referees for their valuable remarks that were highly supportive in improving this paper.

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Part V

Value Chain Models: Complexity

Chair:

Jan Olhager

Complexity in Global Value Networks: Facilitation of Value Network Boundary Spanning Decisions from a Complexity Perspective

Corinna Engelhardt-Nowitzki, Markus Gerschberger, and Franz Staberhofer

Abstract Dynamic environments and the force to satisfy changing individual customer needs economically increase the complexity in value networks. In practice, there is a lack of knowledge regarding the question at how to assess network complexity and to subsequently decide which value network segments are 'critical' and thus have to be treated with priority and which can rather be neglected in managerial considerations ('network boundary spanning'). This applies especially, when information is incomplete. The theoretical fundament is discursive, ambiguous and sometimes vague. If solutions are tangible, they often have a narrow application scope. In particular, a manager would require a means to quickly identify those 'critical' network elements (customers, suppliers etc.) that are disadvantageous due to an inadequate degree of complexity. Based on considerations from value network management and complex systems theory and on a thorough literature review, the present paper proposes a framework to determine managerial decisions in the course of value network boundary spanning. Besides, a generic set of complexity-related parameters is deduced from the literature that allows for a more appropriate determination of 'critical locations' within a value network.

Keywords Decision framework • Network boundary spanning • Value chain • Value network complexity • Vector-based network topology

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_12,

1 Complexity Issues in Dynamic Value Networks

Dynamic environmental conditions lead to a rise of complexity in economic value networks. Practitioners and scientists are aware of this development but sufficient means to successfully handle complexity in such networks are not available yet (Schuh et al. 2008a). This negatively affects internal enterprise planning and steering as well as the coordination of the surrounding network. Therefore the purpose of the present paper is to propose a framework to determine managerial decisions in the course of network boundary spanning. 'Boundary spanning' in this context means to identify those network knots or segments that have to be inspected with high priority due to their notable impact on the acting company. Besides, a generic set of complexity-related parameters is deduced from the literature that allows for a better determination of such 'critical' locations in a value network under given business conditions.

In this regard, a main complexity driver is the multifaceted topology of a value network. Some attempts have been made to describe the generic structures. For instance Lambert et al. (1998) proposed a reversed left to right configuration (Fig. 1).

However, this model neglects the existence of further linkages. For example a supplier might deliver comparable goods to more than one company or a customer might apply a dual or multiple sourcing strategies.

A similar model is proposed by Gosling (2003). This approach introduces "middlemen" (p. 2,322), herewith indicating that more than just one acting company might influence the supplier's and customer's behaviour in a competitive manner. The described "middleman process" (p. 2,325) is, though simplified, a suitable assumption for practical operations: the customer sends an enquiry. The middleman tries to fulfil this request, hence negotiating with suppliers and finally receives an acceptance or rejection for his proposed delivery capability. However, this model omits continuative flows beyond $tier_2$ customers or suppliers (Fig. 2).

Both models are at first sight suggestive of a good capability to apply quantitative optimization methods or heuristics, especially, because spanning tree structures

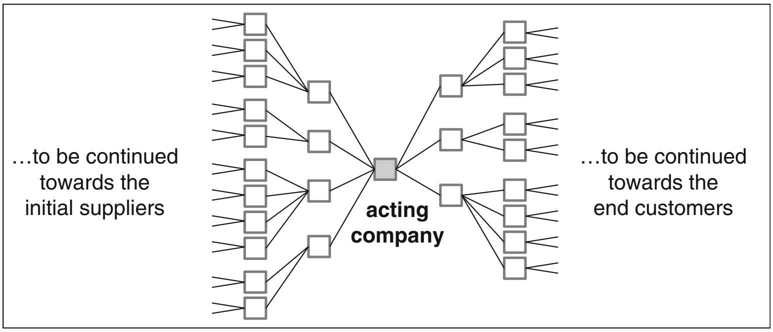

Fig. 1 Supply chain model according to Lambert et al. (1998), simplified illustration

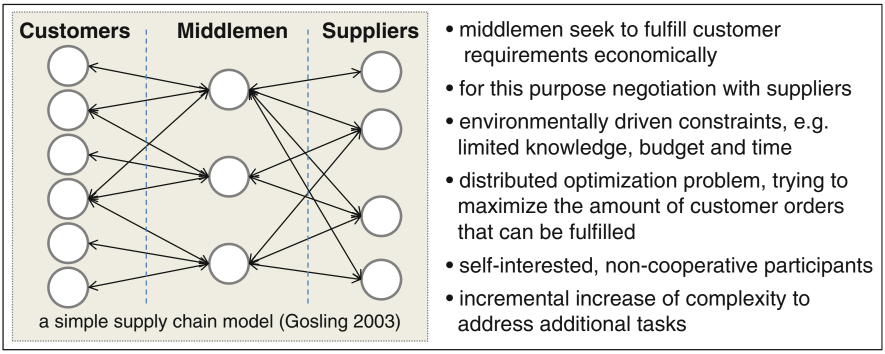

Fig. 2 Supply chain model according to Gosling (2003)

or bipartite graphs provide a good base for such algorithms. However, in practice, dedicated constraints often make it impossible to use such algorithms. For instance the (realistic) assumption of opportunistic behaviour suspends the chance to use constraint satisfaction techniques in the second model (Gosling 2003). In other cases a certain algorithm might be feasible but require excessive computational effort. It depends much on the given situation, whether simplifying assumptions that enable computability can be practically applied. A method to verify the applicability of simplifying assumptions or to propose a less complex network model topology could be a beneficial preparation for the subsequent use of quantitative means.

For this reason and for the purpose of modelling concrete practical scenarios, both models would require decision means on each tier-level, how many and what knots to include or to exclude according to their 'criticality'. A knot is assumed to be 'critical', if its complexity impact on the whole model – especially on the focal (acting) company – causes relevant inopportune performance impacts.

In addition to complexity influences that are related to the network structure manifold further complexity-enhancing issues may impact a value network:

- A customer-specific business that satisfies a lot of customers with multiple product variants (Thonemann and Bradley 2002) is difficult to operate if two conditions arise coincidentally with each other: first the customer requested lead time is remarkably shorter than the time required by the acting company to handle order coordination, parts supply, internal production and delivery. Second the forecasting horizon doesn't sufficiently facilitate a company's planning procedures and, if applicable, also preproduction.
- Most companies are able to analyse dependencies between a customer order and the necessary production or supplier performance for a single product using e.g. the bill of materials. However, the performance of available-to-promise mechanisms under complex conditions, e.g., if more than one plant is involved or in a build-to-order setting, is not sufficient (Tsai and Wang 2009).

- Even if a research project would elaborately assemble relevant value network topologies into a generic network structure, the applicability of the resulting model would be limited: the amount of participants and links would inhibit a processable configuration in most practical scenarios due to the number of elements, relations and constraints. Further the model would suffer from incomplete information. This especially applies for network participants that have no direct contract with the acting company: in these cases the data accessibility is even lower than within a dyadic buyer-seller relationship.
- Even assuming that these issues could be validly solved, further complexity arises from the fact that the singular network participants will have differing network conceptions. For example in a buyer-vendor relation, the buyer (e.g. a fire-truck manufacturer) might evaluate a certain supplier as important because the delivered parts (e.g. highly resilient tires) have a strategic importance. Vice versa the vendor (a tire producer) might regard this buyer as unimportant because of its low purchasing volume.
- A final and often neglected issue is the fact that the participants have a different ability to influence their environment due to their competitive strength.

Hence, a value network is a heterarchical system (Ahlert et al. 2009) consisting of actors (companies) with a varying influence, who have subjectively differing conceptualizations of the business environment. Since information is incomplete and the number of directly contracted network partners is already too high for exhaustive analysis, a company has to decide which $tier_1$ customers and suppliers are to be managed with high effort and attention and which are not. A second consideration has to be made to distinguish between relevant ('critical') and less relevant network parties with a $tier_2$ – $tier_n$ position from the view of the focal company: also a not directly contracted company can have remarkable influences and therefore will have to be treated with priority (being assessed as 'critical'). Although still simplifying, Fig. 3 demonstrates the complexity that arises from an elaborately reasoned network view. The grey-shaded area represents the necessary network boundary decisions: knots inside this area are evaluated as critical, knots outside are not and thus may be neglected within managerial considerations. The more companies on a $tier_2$ – $tier_n$-level are critical because of their impact on the focal company, the more difficult and unstable respective value network analyses (e.g. regarding required inventory, expected replenishment lead times or delivery reliability) will most probably be. Beyond pure network topology issues, additional issues arise e.g. regarding the appropriate balance between centralized and decentralized coordination and the adequate exposure to distributed intelligence.

Proficient supply chain coordination is reliant on accurate and exhaustive information (Holweg and Pil 2008; Caridi et al. 2010). However, a rising network complexity increases intransparency and extends the necessary information to describe the system and its current state (Sivadasan et al. 2006). Moreover, Fig. 3 covers only one singular network perception. Another company would have a different view. This leads to a multiple bundle of overlapping perceptions that dynamically interact with each other under the conditions of incomplete information and opportunism (cp. Coase 1988 or Jensen and Meckling 1976). The mutual interdependencies are altogether establishing a complex and dynamic system (Fig. 4).

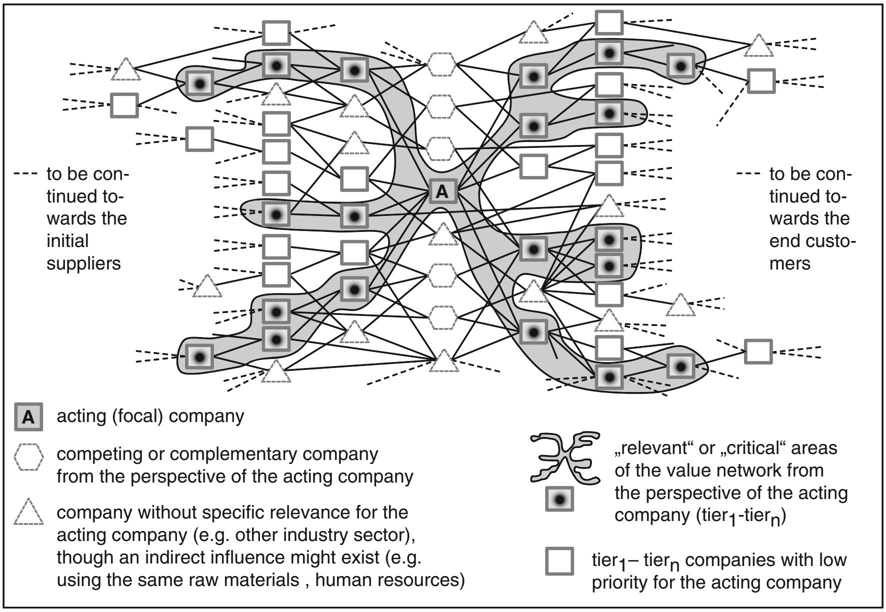

Fig. 3 Value network conceptualization from the singular perspective of one acting company

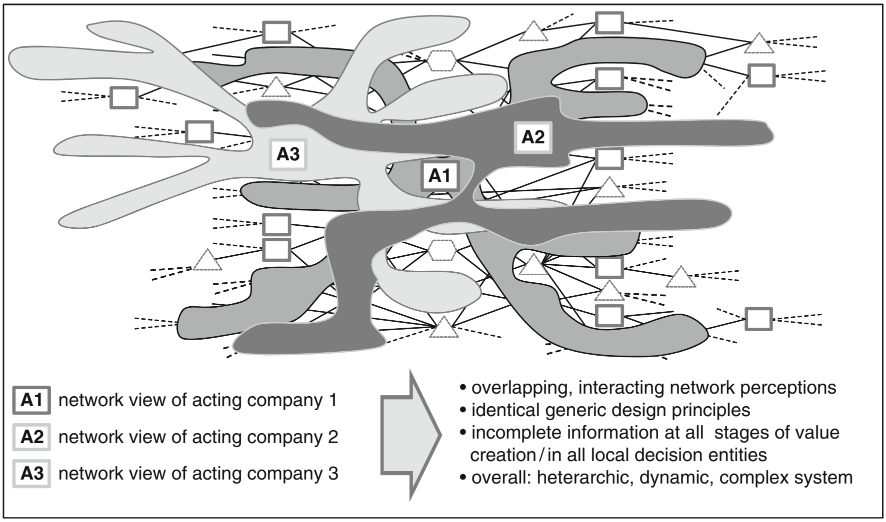

Fig. 4 A value network as a complex and dynamic system of overlapping singular views

This is often approved in the literature, especially in contributions that assume a value network to be a complex adaptive system (CAS). E.g. Surana et al. (2005) enforce the study of CAS to identify commonalities among complex systems in domains like biology, social systems or ecology in order to better understand complexity-related laws of nature. They propose the use of CAS concepts to characterize and model supply-chain networks. Thereby a particular emphasis is put on the overwhelming amount of interdependencies between network entities, the non-linear nature of the network and the self-organizing evolvement which altogether complicate managerial intervention. Further they recommend that "managers must appropriately balance how much to control, and how much to let emerge" (p. 4,236). Since the decisions in a value network are taken on the level of the single companies, managerial efforts and complexity considerations have to be set individually. According to CAS-principles, developments will often depend on the history and current status of the respective company, thus requiring a situational, well-tailored complexity evaluation and handling of "emergent properties that are not reducible to those of its constituent parts" (Hodgson 2000).

Summarizing it can be stated that the objective of identifying critical complexity-related influences in a value network from the managerial view of a singular company is challenging due to the inherent nature of a value network as a heterarchical, dynamic, intransparent and complex system. This becomes increasingly decisive for a company if the necessary (re-)action times in the face of external impulses exceed the internal operation speed, e.g. in a build-to-order environment. Even if the design principles of a value network are rather determinable on a generic modelling level, a higher granularity goes along with unmanageable complexity amplification. Attempts to manage value networks do frequently cause frustration due to the failure to predict and control dynamic, complex networks, especially if impacts originate from $tier_2$ and $tier_3$ suppliers (Choi et al. 2001).

Simplified models as e.g. proposed by Lambert et al. (1998) or Gosling (2003) need to be further developed in two ways to gain a proficient capability to identify critical network segments: first the network topology mustn't remain limited to purely hierarchical and strictly diverging (or converging) tree-structures. Second a sufficient parameterization has to be established in order to assign relevant attributes to network entities (companies) and their relational links (co-operations). According to the attributed parameters, knots can be evaluated regarding their criticality, thus altogether determining the network boundaries (Fig. 3).

Thus, the paper is structured as follows: Section 2 outlines implications from the theory of complex systems, provides a thorough literature review regarding the question how to determine complexity in a value network and deduces complexity-related 'core parameters'. Section 3 discusses measurement and operationalization issues and presents a vector-based decision framework for the purpose of identifying critical network segments from a complexity perspective. Section 4 reflects on the significance of the findings, provides managerial implications and indicates research needs.

2 Complexity Drivers in Value Networks – Literature Review

Section 2 compiles the conceptual fundament for this paper. First (2.1) basic assumptions of the complex systems theory are discussed. Second (2.2) literature research is presented regarding possible value network complexity-parameters.

2.1 Implications from the Complex Systems Theory (CST)

Due to actual turbulences in value networks the interest in approaches from system theory, CST and related fields has grown (Tielebein 2006). These disciplines touch a broad range of interest (e.g. physics or biology), also including non-technical fields (sociology, economics etc.). Beginning with natural systems and proceeding to the investigation of artificial systems, a gradual maturing from simple to increasingly complex systems can be observed (Shahabi and Banaei-Kashani 2007). In particular, decentralized approaches, e.g. the theory of loosely coupled systems (Orton and Weick 1990), have gained attention. Bar-Yam (2003) subsumes such efforts under the term 'complex systems theory'. Since CST is based on several monodisciplinary sciences (Kappelhoff 2000), it can be seen as a meta-theory combining research effort to investigate complex systems (Shahabi and Banaei-Kashani 2007). One objective is to condense evolutionary principles and patterns from the underlying disciplines to gain insights into the behaviour of complex systems (Gomez 1981), e.g. a firm or a value network (Tielebein 2006).

An inherent characteristic of CST is that in contrast to traditional reductionism a holistic perspective is applied that respects non-linear coherencies and a constant change of the involved entities (Manson 2001; Anderson 1999). A complex system is also adaptive if the entities change their behaviour as a consequence of events that occur from element interaction in a self-organizing way. Whereas reductionism seeks to best possibly simplify a coherence using general laws, relying on linear causalities and assuming external controllability, a holistic, system-oriented approach pays stronger attention to the relations of a system, assuming also circular causalities (Tarride and Zuniga 2010). A main difference to mechanistic thinking is that "the whole determines the parts, and that these and their relations are defined in relation to the whole" (p. 1,116). Unexpected developments may occur that are not necessarily caused by external impacts but can emerge as an inherent part of the internal system behaviour (Hodgson 2000; Choi et al. 2001).

Comparable to CST also the conceptual roots of 'complexity' originate from a multifaceted range of disciplines (Manson 2001; Tarride and Zuniga 2010), e.g. *information theory* (Shannon and Weaver 1963; Frizelle and Woodcock 1995; Sivadasan et al. 2006), *system theory* (e.g. Gomez 1981; Bliss 2000), from *evolutionary approaches* (e.g. Kauffman 1993; Meszena et al. 2001) or from the field of *CAS* (e.g. Holland 1992; Gell-Mann 1995; Hodgson 2000; Choi et al. 2001; Surana et al. 2005; Choi and Krause 2006). A joint concern of CST and neighboured researchers is the investigation of how a complex behaviour can emerge from rather simple actions between singular system elements (Choi et al. 2001), e.g. in a dyadic buyer-seller relation. According to CST neither system control nor the anticipation of developments is granted (e.g. Manson 2001). A value network is a CAS insofar as a lot of participants interact with each other simultaneously via manifold information and material flows under uncertainty (Sivadasan et al. 2006). Also a logistics system is a complex system consisting of actors that interact with each other in the face of conflicting objectives (Stock and Lambert 2001).

The complexity comprehensions implied in the listed disciplines mostly remain on an abstract level. A major reason for this is that the meaning and the value of complexity depend on the nature of the investigated system (Scuricini 1988). Though economic value networks can be recognized as CAS (Choi et al. 2001), none of the above concepts has been adequately transferred to this domain to the best knowledge of the authors. This especially applies for approaches from systems theory (Dekkers et al. 2005), although there is empiric evidence that companies that applied a holistic complexity absorption strategy towards turbulences were outperforming others with a mechanistic complexity reduction response (Ashmos et al. 2000). Hence, the challenge for complexity research is the identification of adequate methods for system representation, the analysis of interdependences between core elements and the specification of complexity parameters (Schuh et al. 2008b).

2.2 A Review of Complexity Drivers Within Value Networks

Since an exhaustive investigation of complexity is beyond the capability of a single research paper, the following paragraph provides a brief complexity outline before presenting the applied literature review design and results.

A widespread complexity interpretation concerns the multiplicity and diversity of the elements and linkages of an entity or system (Butts 2001). Another frequently mentioned matter is the change velocity of entities, also referred to as ‘dynamics’ (Blecker et al. 2005; Schuh 2005). Several authors (e.g. Bozarth et al. 2009; Wycisk et al. 2008; Meyer 2007; Engelhardt-Nowitzki and Zsifkovits 2006; Choi and Krause 2006) have analysed various complexity conceptualizations. The congruent conclusion is that the abstract, heterogeneously defined and multifaceted term ‘complexity’ can only be described indirectly using substantiated complexity parameters. This is explicitly confirmed in Kirchhof and Specht (2003). However, it is difficult to identify valid parameters and to operationalize them (Westphal and Kummer 2001). Hence, subsection 2.2 presents a thorough literature review to assort relevant complexity issues. Since a selective review can’t cover even a representative percentage of the innumerable research contributions and thus will have biases, a triangulation setting (Jonsen and Jehn 2009) was used:

- Step 1: *data sources* were diversified into *three streams* within a rather formalized and structured review approach: (1) *academic journals* (from Gerschberger et al. 2011, extended), (2) *monographs* (done in this paper) and (3) two substantial current *research projects* (done in this paper) ⇒ *data triangulation*
- Step 2: ⇒ *investigator triangulation* was used by reviewing the data (all three streams) through each researcher separately, followed by joint consolidation
- Step 3: the researchers utilized *additional sources* (beyond the three streams) from recognized academic journals on occasion and in an *explorative manner* ⇒ method and data triangulation

During the steps 1 and 2 a previous review of academic journals (Gerschberger et al. 2011) was *re-reviewed* against complexity parameters identified in a sample of monographs and findings from two research initiatives: 'COLL-PLEXITY' (RWTH Aachen, University St. Gallen, Hungarian Academy of Science) and the 'Manufacturing Complexity Network' (Universities of Cambridge and Oxford). Gerschberger et al. (2011) have conducted a rigorous analysis in 12 top-ranked SCM-journals, yielding into 19 'core publications' out of 157 preselected papers.

Table 1 lists the journal review results (stream 1), distinguishing two clusters: Parameters that originate from the value network structure (complexity-determining) and external parameters (complexity-influencing). Three additional parameters, 'heterogeneity of elements', 'heterogeneity of relations' and 'dynamic' (not regarded as relevant in Gerschberger et al. 2011) were added in the course of the present extended *re-review* because the monograph review (stream 2) and the analysis of the research projects (stream 3) gave evidence for their relevance.

As a further confirmation we suppose the fact that the identified parameters are almost congruent to the findings in Masson et al. (2007), Bozarth et al. (2009) and Milgate (2001).

To secure the quality of the monographs the focus was mainly on doctoral theses and continuative references cited there. Both reviews – journal publications and monographs – are in good agreement regarding basic value network complexity parameters. Interesting is the high number of mentions for the parameters 'dynamic', 'heterogeneity of elements' and 'heterogeneity of interrelations'(the latter often hand in hand with each other) in the monographs, whereas 'uncertainty' and 'geographical components' received less mentions. Table 2 displays the review results in the monographs.

Finally, the parameters were matched with those identified within 'COLL-PLEXITY' and the work of the 'Manufacturing Complexity Network'. This further step again confirmed the plausibility of the identified parameters as only one difference resulted regarding the importance of the parameter 'dynamic': Dynamic is considered as relevant in both initiatives, whereas in the journal review it had rather been a tentative parameter that might gain more importance in the future.

Table 1 Complexity parameters as per number of mentions (Gerschberger et al. 2011, extended)

	Structural complexity-determining parameters				Complexity-influencing parameters			
Author	Number of elements	Heterogeneity of elements	Number of interrelations	Heterogeneity of interrelations	Uncertainty	Dynamic	Customer-driven product variety	Geographical components
(Milgate 2001)	■		■		■		■	■
(Prater et al. 2001)	■		■		■			■
(Choi and Hong 2002)	■							
(Sivadasan et al. 2002b)					■			
(Guide et al. 2003)	■							
(Oke 2003)	■				■			
(Vickery et al. 2004)					■		■	
(Sanchez and Perez 2005)					■			
(Choi and Krause 2006)	■		■				■	■
(Stonebraker and Liao 2006)	■	■						■
(Meepetchdee and Shah 2007)	■		■					
(Jonsson et al. 2007)	■		■					■
(Masson et al. 2007)	■				■		■	■
(Christensen et al. 2007)					■		■	
(Closs et al. 2008)							■	■
(Kinra and Kotzab 2008)								■
(Wycisk et al. 2008)	■		■			■		
(Bozarth et al. 2009)	■				■	■	■	■
(Hofer and Knemeyer 2009)	■					■	■	
Total	13	1	6	0	9	3	8	9

The *overall review result* is: the initial argument that complexity can only be described by using a set of appropriate parameters was confirmed, in particular:

- The *numerousness of elements* and *interrelations* that make up the system,
- The *degree of uncertainty* that enters the system,
- The *product variety requested by the customers*,
- The inherent *dynamics* and
- *Geographical components* that act on the system.

The two items *heterogeneity of elements* and *of relations* are of minor relevance compared to this item list. Since the literature review was selective, not exhaustive, the authors are aware of the fact that other parameters might also be important. In

Table 2 Review of the results against parameters identified within monographs

Author	Number of elements	Heterogeneity of elements	Number of interrelations	Heterogeneity of interrelations	Uncertainty	Dynamic	Customer-driven product variety	Geogr. Components
(Luhmann 1976)	■	■	■					
(Ulrich and Probst 1988)	■	■		■				
(Bohne 1998)	■	■	■	■		■		
(Gomez and Probst 1999)		■	■			■		
(Heina 1999)	■		■					
(Liening 1999)	■		■	■		■		
(Malik 2000)				■			■	
(Lawrenz 2001)	■	■	■					
(Gino 2002)			■		■		■	
(Sivadasan et al. 2002a)					■		■	
(Kirchh of and Specht 2003)	■		■			■	■	■
(Scherf 2003)	■		■			■		
(Vester 2003)	■	■		■		■	■	
(Hasenpusch et al. 2004)	■						■	
(Blecker et al. 2005)		■			■	■	■	
(Schuh 2005)	■					■		
(Engelhardt-Nowitzki and Zsifkovits 2006)	■		■				■	■
(Ivanov 2006)	■		■		■	■	■	
(Kaluza et al. 2006)	■		■		■	■	■	
(Klaus 2005)	■	■	■	■	■	■	■	■
(Piller 2006)	■					■	■	■
(Csáji and Monostori 2008)	■	■			■	■	■	■
(Mainzer 2008)	■				■	■		
(Moder 2008)	■		■					
Mentions in monographs	19	9	14	6	8	14	13	5
Mentions in journal publications	**13**	1	**6**	0	**9**	3	**8**	**9**
Total number of mentions	32	10	20	6	17	17	21	14

particular, situational or company-specific issues might have to be regarded additionally. The identified parameter set provides a solid starting point for a feasible boundary spanning decision framework: Attributes like the numerousness of value network elements or linkages can be easily derived from the network topology.

Also product variety is a rather accessible parameter. Uncertainty, dynamics or geographical issues could be represented through respective scales.

3 Operationalization and Measurement Issues

Obviously there is no universal complexity definition. Value network complexity is evidently related to a range of structural attributes, which, however, need further operationalization. Thus, Sect. 3.1 discusses respective concepts and obstacles. In Sect. 3.2, a vector-based decision framework is introduced to support the identification of critical network points in the course of network boundary spanning.

3.1 Measurement and Operationalization of Complexity

A wide range of formalized approaches have developed complexity-related measurement means. E.g. information theory is frequently using metrics such as the run-time behaviour of an algorithm. The network theory often gains insights through measures related to graph theory (Butts 2001). Another widespread measurement approach is based on entropy (e.g. Wu et al. 2007 for customer-supplier systems). Some authors (e.g. Kaluza et al. 2006; Caridi et al. 2010) have proposed concrete complexity metrics. Further, numerous scales have been proposed for specific complexity matters, often tied to a respective conceptual framework (e.g. Ashmos et al. 2000; Größler et al. 2006; Schoenherr et al. 2010). Other approaches claim that logistics complexity can be measured only qualitatively, often also developing respective measurement scales (e.g. Hofer and Knemeyer 2009). Altogether, measurement attempts are manifold, disputed and do strongly depend on the individually applied complexity definition.

A further complicacy results from the fact that the data is usually obtained from sources that are exposed to subjective human influences. The decision whether a complexity impact is relevant or not is managerial and therefore an individually varying decision. Thus, any complexity measurement approach remains subjective, even if the applied scale and indicators are objective. Such kinds of shortfalls regarding the validity have been factually observed e.g. in a meta-analysis regarding process measurement conducted by González et al. (2010): surprisingly complexity was the item considered most measurable by the majority of investigated authors (44%). However, at closer look, the respective complexity measures showed lacking standardization and theoretic validation and "would appear that they are actually quantifying understandability and/or changeability" (p. 121).

Finally complexity evaluation depends on the applied scientific perspective. If, as claimed in the CAS-approach, a holistic, system-oriented perspective is applied rather than a reductionist view, measurement has to consider behavioural attributes of complex systems, in particular *self-organization* and the *emergence* of new structural and behavioural patterns that are not caused by general coherences but depend on the singular system (Espinosa and Porter 2011). The authors conclude that the specific CAS attributes are not necessarily tied to competitive success.

All in all, we have to state, that a proven and universal causality between a certain degree of complexity and the performance of a company doesn't exist. Respective research results and empiric findings are once more heterogeneous and contradictory. Basically three types of contributions can be distinguished:

- *Conceptual papers* without empiric evidence; some of them assume a coherence like 'increased complexity inhibits performance', some deny such causalities. Others believe that this is a situational issue. E.g. Choi and Krause (2006) assume that complexity reduction may reduce transaction costs and increase responsiveness, though raising supply risk and restricting supplier innovation.
- *Contributions with empiric evidence* that *have observed* such coherences, e.g.
  - Hasenpusch et al. (2004): bivariate correlation analysis has shown that higher complexity leads to longer lead times and reduced delivery reliability
  - Lewis and Sheinfeld (2006): participants confirm that complexity management is important to improve on-time delivery, inventory, quality and cost
  - Manuj and Mentzer (2008): evidence that less complex supply chains are better able to manage supply risks and improve performance
  - Perona and Miragliotta (2004): data suggest that decreased complexity could reduce uncertainty and therefore stock and capital costs
- *Contributions with empiric evidence* that *have not observed* such coherence; e.g. Mahler and Bahulkar (2009) state that there is no compulsory causal relation between the number of SKUs and the achieved market share, though complexity is a cost driver. It depends on the individual business, whether the higher costs are overcompensated through market share and revenue gains or not.

Summarizing, there are three essential conclusions: first, complexity impacts on a business may not by implication be operationalized objectively and uniquely like a general law or a universal set of well-validated key figures, though commonalities exist on an abstract level (cp. Tables 1 and 2). The coherence between a certain complexity degree and a business performance level is not compulsory, but depends on the individual course of a business. Research findings are contradictory.

3.2 Representing Complexity in a Decision Framework

As stated in section 1, practical implementations have to be based on a specifically customized network topology, guided by the generic understanding presented in Fig. 3. Thus the decision is essential, what knots to include or to exclude in the course of value network boundary spanning. Thus, the identified complexity parameters (Sect. 2) have to be integrated in a respective decision framework. In this regard we have combined and further developed the ideas of two existing

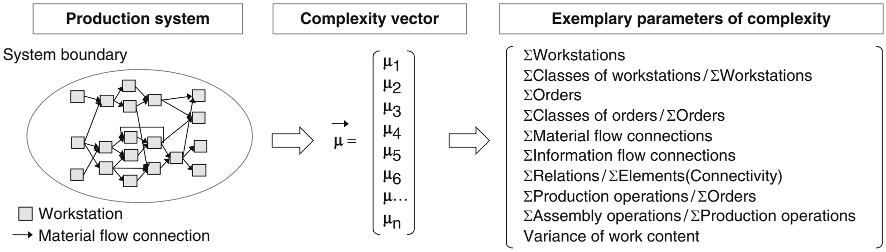

Fig. 5 Characterization of the production system's complexity by vectors (Windt et al. 2008)

models. This is first Windt et al. (2008), who proposed to represent complexity issues using vectors, but without respecting network topology questions. This is second Müssigmann (2007), who proposed a vector-based supplier model, but neither incorporated complexity issues nor included outbound-related influences nor considered the necessity to establish a selected view on relevant value network segments through respective boundary spanning.

Windt et al. (2008), based on Costa et al. (2007), proposed to determine the complexity of a production system using a complexity vector (Fig. 5).

Windt et al. (2008) mention two measuring intentions: either two systems or two states of the same system can be compared with each other regarding their complexity via a $\Delta\mu$. Herewith they state concurrently with our findings, that the complexity parameters may vary depending on the respective system. Subsequently they propose a "complexity cube" (p. 198) that uses multiple vectors in order to cover different complexity dimensions. Since a valid quantitative measurement is stated to be impossible, a comparison is done on an ordinal level only, using exemplary complexity parameters. A more elaborate parameter definition is indicated to be a matter of further research needs. Exactly this research need is addressed in the present paper, since we have systematically identified such parameters to determine complexity in value networks. In doing so, we also extended the focus from an internal production system (Windt et al. 2008) to a cross-company value network perspective.

Second, we extended a graph-theoretic supplier evaluation model proposed by Müssigmann (2007). Starting with a single root (the focal company) and continuatively enclosing associated supplier flows in the form of a tree structure, the supply-side of a value network is mapped. The model consists of edges and knots, each relation (=edge) representing a dyadic connection between two companies. Each knot embodies a single company. Both, edges and knots are represented through an evaluation vector that can cover variable parameters, e.g. lead time, cost, delivery reliability or product quality (p. 233ff). Step 1 in Fig. 6 illustrates the creation of an evaluation vector, though, in contrast to Müssigmann (2007) we are using the complexity-related parameter item list that was identified in section 2. As complexity may occur at the company as well as on the co-operation level (Kaluza et al. 2006), there is a good fit with the given model structure that also assigns evaluation vectors to edges and knots.

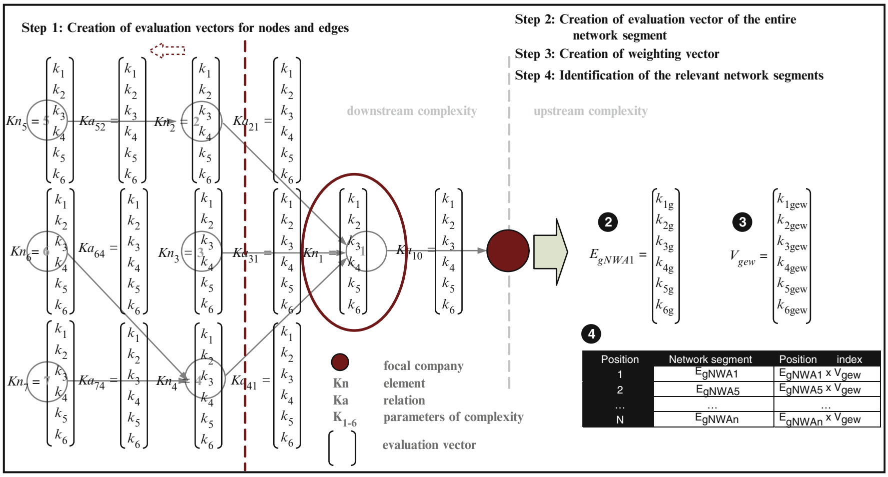

Fig. 6 Conceptual model to analyse supplier networks; Müssigmann (2007), extended

The consideration of all suppliers involved in a network segment seems desirable at first glance, but has to be considered in the face of significant challenges such as the number of entities to investigate, resulting effort and data availability.

Therefore we suggest to use an iterative approach that analyses direct ($tier_1$) customers and suppliers first, distinguishing between relevant ('critical') and not relevant ('non-critical') according to the evaluation vectors. In doing so, a different analysis intention has to be applied downstream and upstream: Whereas customers have to be investigated according to their *complexity requirements*, suppliers have to be analysed regarding their *complexity contributions*. Complexity contributions might predominantly imply complexity enhancement, but could also represent a complexity reduction, if for instance comparing the case of modular sourcing from one key-supplier against component sourcing from multiple suppliers. Other than Müssigmann (2007), the consolidation logic towards the impact on the focal company has to integrate two different streams (sell-side complexity requirements and buy-side complexity contributions).

Following the idea of representing the existence of competitors through "middlemen" in Gosling (2003, p. 2,322), two principle modelling alternatives are thinkable: either a third additional trace of edges and knots could be added to the model network topology or the complexity requirements of customers could be parameterized in a way that incorporates the competitive environment, e.g. respecting the conditions that would motivate customers to buy from the focal company instead of purchasing elsewhere. For simplicity reasons and since a well-working sales and operation process should have the required information available, the latter alternative is clearly preferable.

If a concrete practical case can be modelled in a way that uses quantified indicators (instead of ordinal, cp. Windt et al. 2008) in the respective evaluation vectors, even a complexity-related cause-impact analysis could be done: For example the impact of the decision to serve a certain customer segment or to offer certain product variants on supplier-caused complexity that has to be handled accordingly, could be determined. Even if a practical implementation of this decision framework would be terminated at this dyadic, $tier_1$-driven stage due to difficulties to proceed with further tier-levels, valuable managerial insights could be achieved.

Assuming major impacts on the focal company that justify respective data acquisition efforts, the model execution would iteratively proceed further upstream and downstream to a $tier_2$ – $tier_n$ level in the value network. Equal to $tier_1$-related analysis, only those knots would be included into further analysis that have in fact been identified as relevant because of their notable influences on the focal company – either regarding their complexity requirements (sell-side) or their complexity contribution (buy-side).

Next, a consolidation into one aggregated evaluation vector for the entire examined network segment is done based on the singular evaluation vectors. Step 2 in Fig. 6 illustrates that in principle for the 'Müssigmann-variant'. Fig. 7 extends this limited scope to an extended value network perspective.

No matter whether restricting the analysis to the supply side or incorporating both, buy-side and sell-side, the central challenge is to determine the aggregation procedures. Questions to be answered for a specific business situation e.g. include:

- How can a generic parameter be operationalized specifically for a company?
- Is the interrelation between the (when indicated operationalized) parameters of a cumulative or multiplicative or of a minimum/maximum nature?
- Are the parameters and relations determined by a mathematic function at all?
- What type of scale would apply best for a certain application, e.g. metric or ordinal? This also regards vector compatibility for subsequent aggregation.
- Is there a universal causality at all or does a certain coherence show emergent characteristics that can't be evaluated through partial system analysis?
- How can a complexity degree that was achieved through the observation of certain measures be reliably tied to its positive or negative performance impacts?

Due to the fact that the investigation of complexity requires a context-specific multi-criteria model, the importance of parameters can differ from one company to another or for one company under different market conditions. This is considered in the model through a respective weighting vector (step 3 in Fig. 6). Finally, a position index for each network segment can be created prioritizing the most important segments (step 4 in Fig. 6). Though not displayed in Fig. 7, also the extended model could use weighting vectors: in a simple case just one single vector is assigned to the aggregated vector, but most probably at least two weighting vectors might be required – one downstream and one upstream. If applicable (and worth efforts regarding the impact on the aggregated vector) also particular network segments or – most circumstantial – singular edges or knots could be weighted differently. Our recommendation is to determine the need of weighting vectors through a sensitivity analysis regarding the parameters of the aggregated vector.

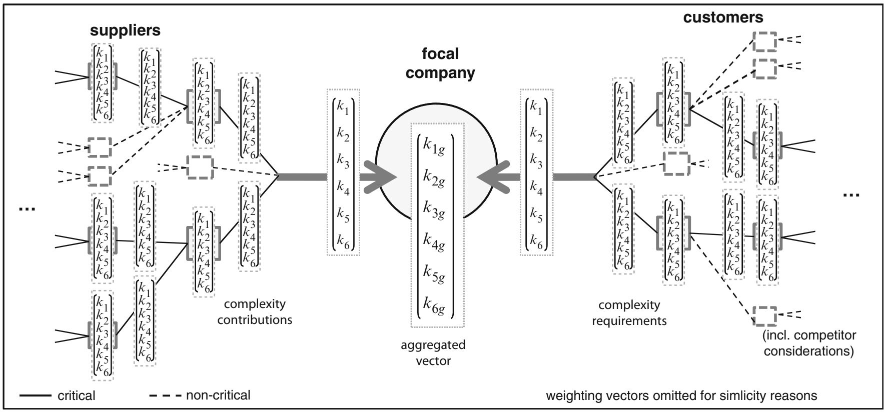

Fig. 7 Decision framework for complexity-driven value network boundary spanning

A sensitivity analysis can also be used to determine the decision whether a knot is assumed to be inside or outside the network boundary: Only those knots (companies) that are critical regarding their overall impact should be included into the relevant value network. Further advantages of the use of sensitivity analysis are at first the possibility to validate model robustness towards inaccurate data or imprecise approximations during the aggregation and at second the investigation of different value network scenarios through parameter variation (e.g. for the purpose of testing a decision to henceforward serve or not serve a new customer segment).

Summarizing, the graph-based vector approach is a beneficial means to map the interdependence of multiple parameter bundles within a value network. The model can be quickly (re-)configured according to an individual network topology and may be easily parameterized for the case of changing conditions. Though Windt et al. (2008) don’t propose the aggregation of multiple vectors at all and Muessigmann assumes a strict tree-topology that is restricted to the buy side of a value network only, a practical implementation may as well model other network structures (Figs. 3 and 7). For most cases, it will not be possible (nor desirable regarding the obtainable accuracy in relation to the necessary effort) to map a ‘whole’ network. We rather recommend to conduct a boundary determination through partial analysis as described above, thus mapping only selected segments including elements from the buy- and sell-side (incorporating further external influences e.g. from competitors within the given parameters). Not only parameter values but as a consequence also the network boundaries may fluctuate over time.

Summing up, our findings helped to integrate and advance existing contributions in the following regards:

- Since as well Windt et al. (2008) as Müssigmann (2007) use exemplary parameters, we have systematically deduced a set of commonly agreed and yet processable parameters that determine value network complexity (section 2). Though a universally valid operationalization is not obtainable, this should at least alleviate and facilitate the specification for an individual business.

- Whereas the first step of purely combining existing models (Windt/Müssigmann) is self-evident after having identified both approaches in the literature, the subsequently conducted modifications offer novel managerial discretion: the use of the framework in Fig. 7 in the course of value network boundary spanning is an applicable decision heuristic in situations where common practices (like customer-, product-, supplier- and part segmentation) are not suitable to identify critical value chain locations, and neither mathematical network optimization algorithms are applicable due to insufficient data and time pressure.
- The use of sensitivity analysis for boundary determination, robustness validation and scenario comparison is a further major advantage; thus as well the evaluation vectors as the necessity to use weighting vectors or the impact of eventually occurring inter-personal judgment differences could be inspected.

Partial analysis is a reductionist means and thus might not sufficiently indicate a surprisingly emerging progression. Even in this case, repeated calculation with changed (or in a scenario mode systematically varied) parameters and sensitivity analysis can help to detect such developments as early as possible: As soon as edging knots lose (or newly gain) their characteristic to be a boundary-knot, this is indicated through the respective elasticity decrease (increase) regarding the root vector. This, however, requires a continuous application as a routine procedure.

4 Conclusions

The *objective of this paper* was to propose a decision framework together with an appropriate set of parameters that allow for a better determination of critical locations in a value network from a complexity perspective. In turbulent markets a corresponding managerial method has to be easy to apply and must provide fast execution to enable continuous application. Our *results* briefly summarized are:

Value networks are heterarchical and intransparent CAS, whose complexity originates as well from its own topology and attributes as from external impacts. Figs. 3 and 4 illustrate the proposed *generic value network conceptualization*. Fig. 7 substantiates the respectively developed *decision framework* to support the identification of critical network segments in the course of boundary spanning decisions.

Though the term *complexity* has been intensively researched, it remains abstract and disputed. Since disciplines with a distinct managerial concern like Logistics or Value Chain Management to our opinion must concentrate on a distinct usefulness in addressing concrete issues, we preferred to further operationalize value network complexity through a bundle of parameters instead of trying to seek for a generic and universally accepted definition. Within the *reductionism-holism debate* in the complex system theory, it remains unsolved how far a whole may be explained through the analysis of its parts (Hodgson 2000; Choi et al. 2001). Though analytical reduction will show lacks regarding emergence effects and can never deliver complete results, our *managerial recommendation* is to permanently conduct a partial analysis as described in section 3 and as also regarded to be "inevitable and desirable" (Hodgson 2000) in the CAS literature. *Limitations* could be derived from the fact that many well-known approaches (e.g. Ashby's law of requisite variety, 1985) are not mentioned here again, since they have been frequently discussed already. Looking at the wide range of academic contributions, we are sure that there are valuable aspects that have not been regarded here.

The proposed *parameterized vector-based framework to determine critical network locations* turned out to be beneficial due to sound configurability and low computational effort. However, our findings confirm Sivadasan et al. (2006) who state that feasible measures to quantify the complexity of supplier-customer relations don't exist. Managers will always have to model their individual businesses. Further we assume that parameter operationalization, scale development, metrics definition and data acquisition will need further research, in particular within prototypical case application and empirical validation. In the current research project, a case study with a build-to-order manufacturer has recently been started.

A further promising *future research direction* is a combined use of this vector-approach (preliminary determination of relevant network topology) with quantitative methods (e.g. an optimization algorithm that is applied on the thus delimited network segment). This, however, requires an adequate parameterization of the vector model, that won't be feasible within all practical scenarios. *Further research need* regards the investigation of more abstract coherences, e.g. adaptability, learning ability and system stability (cp. Größler et al. 2006). Also the design (and the enforcement of academic and practical acceptance) of a management approach that, like cybernetic systems, incrementally responds to changes is a relevant issue – if necessary, even based on changeable target indicators (not to be mistaken for an unfavourable 'moving target' approach).

Altogether the *main managerial value* of this paper lies in an advanced ability to identify critical value network locations through facilitating network boundary decisions from a complexity perspective, and at the same time extending the respective *academic* knowledge fundament.

Acknowledgments The authors wish to thank the two anonymous referees for their valuable remarks that were highly supportive in improving this paper. We also thank the Upper Austrian Government for supporting the research project AGTIL (adaptive value creation, integrating technological, sociological and logistical issues), in particular "ASC – Adaptive Supply Chain".

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Measuring the Cost of Complexity in Supply Chains: Comparison of Weighted Entropy and the Bullwhip Effect Index

Michael J. Gravier and Brian P. Kelly

Abstract Integration has formed the core of logistics and supply chain literature since the 1980s, but empirical research indicates that it does not always lead to better performance. This research effort endeavors to apply information theory to begin to assess the cost of complexity in supply chains. Extant research into supply chain complexity remains in the formative stages, so the purpose of this research is to explore the utility of entropy as a means of comparing alternative supply chain strategies and structures. Simulation experiments revealed that when compared to the bullwhip effect index, an index based upon weighted entropy offered superior assessments of supply chain performance when comparing the effects of safety stock and information sharing, but exhibited performance equally poor to the bullwhip effect index's for predicting the effect of changing the number of echelons in a supply chain. This research lays the foundation for future research that will expand the weighted entropy formulation to account for differences in the number of supply chain players as well as the effect of different demand scenarios.

Keywords Bullwhip effect • Complexity • Entropy • Information distortion • Supply chain management

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, DOI 10.1007/978-3-7908-2747-7_13,

1 Introduction

Integration has formed the core of logistics and supply chain literature since the 1980s, but empirical research indicates that it does not always lead to better performance (Fabbe-Costes and Jahre 2008). Although operationalization and measurement difficulties likely account for a part of these findings, this paper takes the position that integration tools have advanced apace with increasing supply chain complexity. For example, in order to create $61.5 billion in total production, US semiconductor and related manufacturers purchased $13.5 billion in materials from 44 other industries (Economic Census 2002). This leads to a situation where a minimum competence at integration is the price of entry for many goods and services supply chains simply as a consequence of increased complexity of products, markets, and business relationships; and supply chain improvement efforts should therefore target complexity. Despite the explosion of complexity in supply chain strategies and structures, little research specifically addresses the topic of complexity and its impacts on the supply chain. This study hopes to contribute to the dialog on finding levers to reduce or manage complexity in the supply chain (Perona and Miragliotta 2004).

This research effort endeavors to apply information theory to begin to assess the relationship between cost and complexity in supply chains. The premise of the paper is that the uncertainty created by complexity provides a stronger predictor for supply chain performance than traditional measures. In understanding the complexity of a supply chain, the problem is an old one defined by two principle questions: the “make or buy” decision of whether to produce for oneself or to contract the production to a specialist, and the question of how to organize within and between organizations (c.f., Alchian and Demsetz 1972; Magill and Quinzii 2002). In an age of proliferation of market offerings and product and service features, controlling complexity also comprises an important component of supply chain risk management (Manuj and Mentzer 2008). Extant research into supply chain complexity remains in the formative stages, so the purpose of this research is to explore the utility of entropy as a means of comparing alternative supply chain strategies and structures relative to the widely used bullwhip effect index.

2 Abbreviated Literature Survey

Complexity arises from the variety resident in a supply chain. Variety means the existence of numerous individual elements some with close connections that interact in a counter-intuitive and non-linear fashion (Perona and Miragliotta 2004). Perhaps the most well studied consequence of the complexity of multiple players in a supply chain appears in Forrester’s (1961) seminal studies. Forrester’s research conveyed the benefits of integrated logistics and business functions during an era when managers sought new business efficiencies (Drucker 1962). Lee et al. (1997)

provided a new term – "bullwhip effect" – for Forrester's observations regarding the consequences of information distortion and this has since become possibly the most studied consequence of supply chain structure and strategy. Disney and Towill (2003) succinctly summarized the literature on the causes and consequences of the bullwhip effect as well as some published empirical measurements.

Sterman (1989), Fransoo and Wouters (2000), and others developed the most commonly used metric for the bullwhip effect. The bullwhip effect index (BEI) is the ratio of the variability of incoming orders to the variability of outgoing orders. Movements such as Six Sigma and "lean" techniques reflect a focus on the importance of reducing variability to improve supply chain efficacy. However, as identified in previous research (Steckel et al. 2004), bullwhip inefficiencies derive from either inefficient supply chain design or errors in managerial decision-making, or some combination of the two. The BEI does not measure either of these causes, but only the consequences in the inventory. In addition, the bullwhip effect index suffers at least four shortcomings as a supply chain measurement. Firstly, the nature of supply chain management requires calculating the bullwhip effect at several different levels in several different ways in order to understand tradeoffs for different supply chain echelons and for different aggregations of products. Indeed, the order of aggregation greatly impacts the calculated bullwhip effect index (Fransoo and Wouters 2000), a fact that greatly limits its utility for comparisons and also increases calculation requirements. Secondly, in looking at comparisons of the BEI across a variety of real-world supply chains (e.g., Disney and Towill 2003), the numbers are not directly comparable. This means that comparing the relative benefits or costs across supply chains is impossible, especially in light of differing demand patterns, company sizes, and other common sources of variability. Thirdly, the BEI provides little explanatory power for situations when information sharing actually deteriorates supply chain performance (Steckel et al. 2004). Fourthly, recent research indicates that the utility of the BEI for reducing inventory or costs varies widely based upon supply chain strategy and structure (Torres and Maltz 2010).

In other words, the BEI can answer the question, "How can variability in the specified supply chain for the specified product aggregation be reduced?" but cannot answer the questions, "What would the best supply chain design be?" or "Why does the supply chain look like this?" or "When is it more beneficial to improve information sharing versus reducing supply chain complexity through disintermediation?" Additionally, a local measure such as the BEI can often lead individual supply chain members to transfer uncertainty and costs to other players (Steckel et al. 2004).

Although numerous studies have assessed the penalties associated with the bullwhip effect, Torres and Maltz (2010) stated that they were unable to discover any studies that compared outcomes of various supply chain strategies on overall supply chain costs models and cycle times. In the study of information distortion and the use of information as a replacement for inventory could benefit from the application of concepts from information theory. Shannon entropy provides a measure of how much additional information is required to correct false information; in other words, information is a measure of the decrease of uncertainty for the receiver (Shannon 1948). Such a measure offers benefits over the BEI because it goes to the root of the value of information shared in a supply chain. If management decision-making does not benefit from particular information, or if additional safety stock does not make up for missing information, managers need to know.

Few studies have applied entropy-based measurements to supply chain assessment in mainstream research journals. Recent application of entropy-based measures to supply chain research.

Although its application to making comparisons of supply chain performance remains untested, it is hoped that the measurement of entropy will provide an objective, non-relative measure of complexity. The assumption of this study is that a certain minimum level of complexity is required for each product-market scenario, with some markets supporting more complex supply chains than others. The measuring of entropy will identify when supply chains should change their structure and relationship strategies, and will also allow comparisons of different supply chains. The simulation will measure entropy of the supply chain under commonly used supply chain strategies, such as just-in-time (kanban) and global information sharing (ERP). Most past models measure relative performance but offer no global measure for what a supply chain ought to or should look like.

3 Methodology

The experimental design is a 2 (number of supply chain echelons) $\times$ 2 (whether or not end market demand information is shared with all supply chain members) $\times$ 2 (no versus 3 weeks of safety stock carried) full factorial. Microsoft Excel 2007 was selected as the platform for developing the simulation model as spreadsheets are an effective if underappreciated platform for system dynamics modeling (Sterman 2000). Examples of supply chain spreadsheet models of the bullwhip effect that have been published in reputable journals include the work of Disney and Towill (2003) on vendor managed inventories and of Dejonckheere et al. (2004) on the impact of information enrichment.

The APIOBPCS model formed the basis of the simulation, in keeping with other supply chain simulations (Disney and Towill 2003; Venkateswaran and Son 2007). The model offers the benefit of being adaptable to a wide variety of supply chain strategies and structures, including VMI, Beer Game, lean and agile strategies (Venkateswaran and Son 2007). A time delay of two between each echelon was selected in keeping with the board game version of the Beer Game. Each echelon used exponential smoothing to forecast demand as it demonstrates the ability to ascertain low ordering costs (Dejonckheere et al. 2002) and reasonable accuracy (Venkateswaran and Son 2004). A graphical representation of the supply chain model appears in Fig. 1.

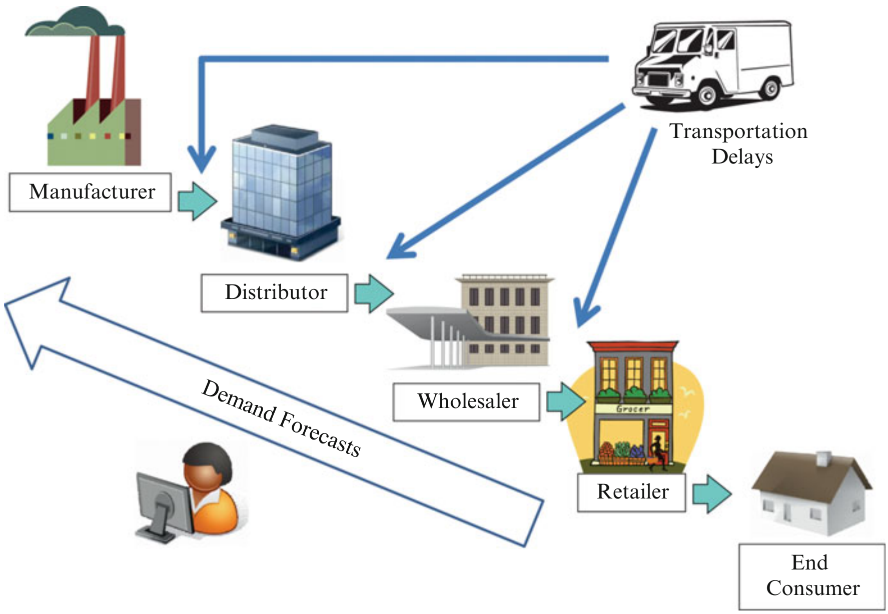

Fig. 1 Graphical representation of the supply chain model

The crucial variables are the customer order, the order placed to the supplier, actual delivery to customer, actual delivery from supplier, and end market demand. A "step up" demand scenario was selected wherein demand doubled from 4 to 8 units at time step 7. In a comparison with S-shaped demand, the "step up" demand scenario was found to be the only demand scenario for which point of sale demand information was unambiguously beneficial (Steckel et al. 2004). It was selected for this study so that a comparison of the benefit of information sharing in a "best case" scenario could be made to elimination of a supply chain echelon. Such a comparison should shed light on this study's assertion that a minimum competence at integration is the price of entry for many supply chains and the circumstances under which information sharing abets the process of increasing complexity.

The dependent variable was measured with both the BEI and Shannon's entropy. The standard formulation of the BEI as the ratio of the coefficient of the variation of orders placed to the coefficient of the variation of the orders received (Fransoo and Wouters 2000). In order to compare these measurements as the simulation progressed, the BEI was calculated based on the history up through each time step.

The standard formulation of Shannon's entropy assesses the distribution of probabilities without regard to the consequences of being in a desired state versus an undesired state. However, many businesses associate a higher cost with backorders when compared with carrying extra inventory. This scenario is reflected in the total cost curve of the standard economic order quantity model. Thus, we modified the entropy formula so that it weighed the cost of backorders higher than carrying extra inventory, while each of those scenarios is considered more wasteful than having the anticipated level of inventory on hand.

The principal consideration for designing our entropy measure is identifying a well-defined set of probability inputs based solely on information a manager could reasonably access. First, at each the individual level, the supply chain player is categorized into one of three states: understocked (indicated by backlogged orders), overstocked (inventory above the target inventory level after considering backlogs), or well stocked. Then, three time step running averages are used to compute the observed probabilities of the various players being in each of these states, $P^* = \langle p_u, p_o, p_w \rangle$ at a time t. This vector will be used to get an entropy value of the entire supply chain at time t.

The Shannon entropy for a probability distribution vector $P = \langle p_1, p_2, p_3 \rangle$,

$$H(P) + \frac{-1}{\ln(3)}(p_1 \ln(p_1) + p_2 \ln(p_2) + p_3 \ln(p_3)) \tag{1}$$

satisfies $0 \leq H(P) \leq 1$ (Roman 1992). But computing $H(P^*)$ unfortunately only measures the distribution of probabilities within P^* without consideration of the costs incurred by being in each state. This leads us to consider weighted probabilities where the weighting induces the entropy measure to rank in order of decreasing costliness shortages, surpluses, and intended inventory levels.

$$\begin{aligned} p_1 &= \frac{1}{3}p_u \\ p_2 &= \frac{1}{3}p_u + \frac{1}{2}p_o \\ p_3 &= \frac{1}{3}p_u + \frac{1}{2}p_o + p_w \end{aligned} \tag{2}$$

Then for $P = \langle p_1, p_2, p_3 \rangle$, the value of $H(P)$ is a weighted measure of the entropy of the system at time t. One can also look at running totals of the entropy to see an index of accumulated wasted in the supply chain.

For comparison, we also look at the Bullwhip Effect index over running totals. This provides a different perspective on inefficiencies accumulating in a supply chain compatible with measures appearing previously in the literature.

4 Analysis and Discussion

Table 1 portrays the BEI, cumulative entropy, and supply chain costs for each combination of factors. Figures 2 and 3 compare the BEI and weighted entropy at each time step of the simulation with safety stock. Figure 4 displays a cumulative plot of the weighted entropy data from Fig. 3. Figures 5–7 display the BEI,

Table 1 Comparison of BEI and entropy

Information sharing	Weeks of safety stock	Bullwhip index	Cumulative entropy	Backlogs	Overages	Process errors
Results for a four level supply chain						
No	3	13.85953	24.88138	17	79	96
Yes	3	7.096962	21.24452	19	55	74
No	0	7.355933	38.21175	82	58	140
Yes	0	3.283364	27.47848	73	30	103
Results for a three level supply chain						
No	3	9.134196	21.42565	11	46	57
Yes	3	6.138986	15.97126	9	33	42
No	0	5.860812	35.49958	61	33	94
Yes	0	2.916498	24.04716	50	19	69

weighted entropy, and cumulative weighted entropy for the case of no safety stocks maintained at any of the supply chain echelons. Insights from using entropy will be compared to the insights from the BEI for each of the experimental factors of number of supply chain echelons, whether or not information was shared, and zero or 3 weeks of safety stock. Comparisons were made based upon the comparability of the results between different experiments, the sensitivity of the measures to the actual costs incurred in the supply chain, and how results compare to past findings. All calculations started from time step 3 in order to prevent division by zero type errors and provide meaningful outcomes.

4.1 Information Sharing

Overall, entropy showed moderate to strong improvement over BEI for discerning the benefits of information sharing for a given supply chain and safety stock policy. Compared to the scenario with information sharing, the BEI is 95% higher in the four level supply chain without information sharing while the cumulative entropy is 17% higher. Defining the number of inventory errors as the number of backlogs plus overages (number of occurrences of inventory exceeding the stock level), the lack of information sharing increases inventory errors by 30% – a much closer match to the entropy results. Making the same comparison for the three level supply chain, BEI exhibits a 49% increase while cumulative entropy increases 34% when inventory errors increased 36%.

Comparing the BEIs for the four level supply chain scenarios with and without information sharing shows that information sharing results in a BEI cut almost by half. Figure 2 also reveals that the BEI changes over time, starting out with more variation in the early stages with information sharing even before the demand steps up. As found in previous research, this reflects that even in a situation that demand does not change, and order quantities are known with certainty, that players in the supply chain reacting independently to consumer demand actually make supply

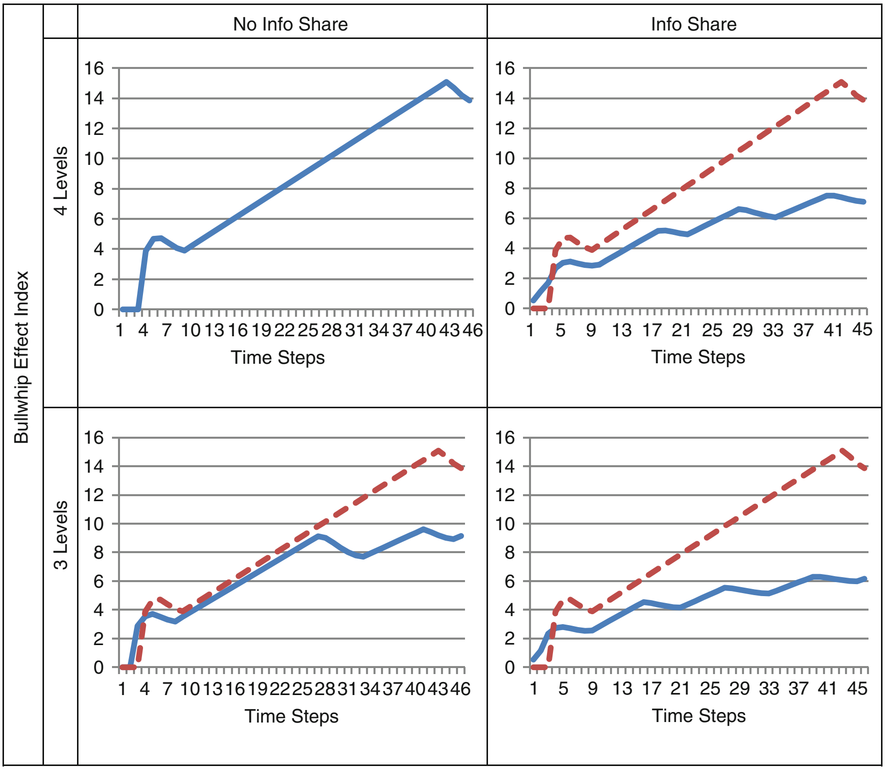

Fig. 2 Bullwhip effect index evolution over time (3 week safety stock)

chain performance worse (Steckel et al. 2004). By the end of the simulation, the BEI exhibits a value just below its peak.

In relation to actual inventory errors which take into account the state of backlog at any given time, the BEI gives little indication that the supply chain went through cycles of over and under-compensating for the end in end consumer demand. The BEI hardly moves, as would be expected because the variance tends not to decrease quickly. In that sense, the BEI assesses the state of end consumer demand variation more than the status of the supply chain's ability to meet it. On the other hand, the entropy measure (Fig. 3) clearly drops when the inventory moving through the supply chain closely approximates actual consumer demand. The fact that this balance of production and demand are few in occurrence appears clearly in the entropy chart. On the BEI chart the scope and magnitude of the imbalances cannot be ascertained.

The ambivalent BEI underscores another fact: in the case that customer demand is met, but the inventory policy is inadequate, BEI will not reveal that supply chain performance was acceptable due to good fortune rather than appropriate strategy. Entropy provided a more accurate reading of how close the supply chain has held to

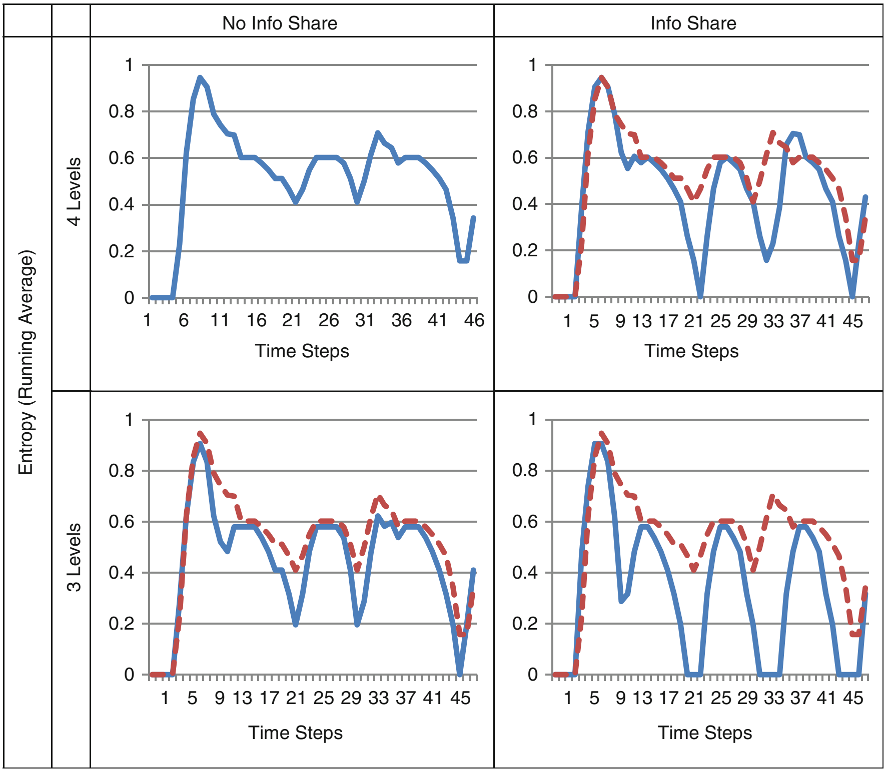

Fig. 3 Running average entropy (3 week safety stock)

the selected inventory strategy, whether the strategy was to maintain 3 weeks of safety stock or none at all.

In the case of no information sharing, BEI again demonstrated the wrong direction and magnitude relative to actual changes in inventory in the supply chain. Whereas BEI increased 88% for the four level supply chain going from three to zero weeks of safety stock and a decrease of 36% in the three level supply chain, actual inventory errors decreased 31% in the former case and increased 65% in the latter. The changes in entropy – a reduction of 35% and an increase of 66% for each of the respective cases – closely matched changes to actual inventory errors while using similar or even less data.

4.2 Structure

An examination of the results for the ability of BEI and entropy to predict supply chain performance in the face of changes to structure indicates that neither measure

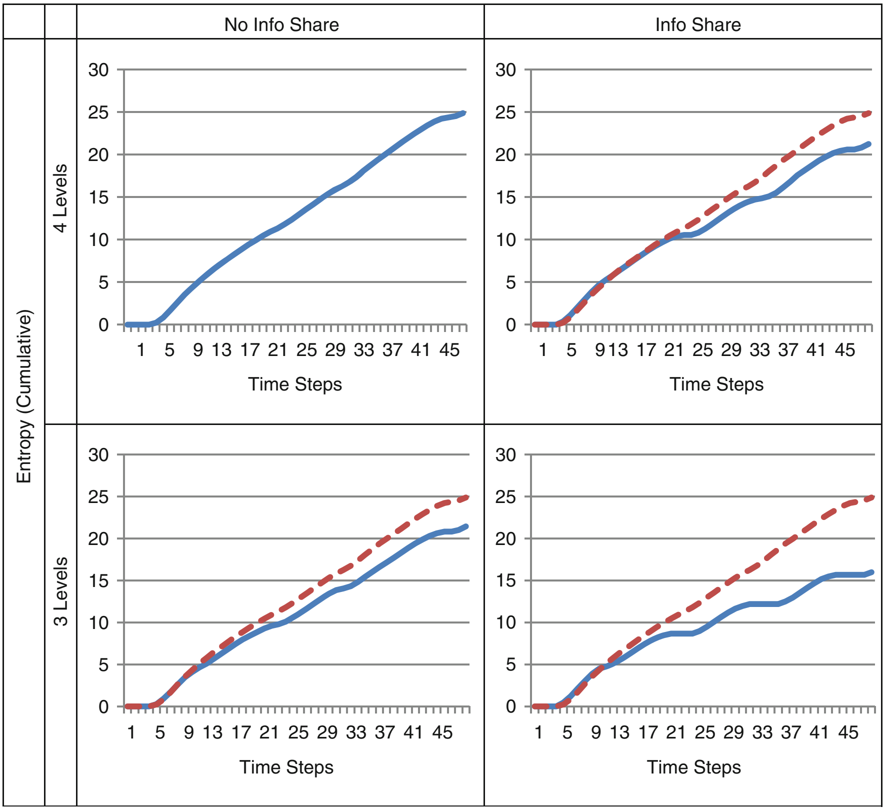

Fig. 4 Cumulative entropy (3 week safety stock)

is well suited to the task. In all cases, when comparing the four level to the three level supply chain with and without information sharing, and with and without safety stock, both BEI and entropy underestimated the magnitude of change in the supply chain inventory errors. In the scenarios with no safety stock, going from three to four levels in the supply chain increased inventory errors 49% without information sharing and 49% with information sharing. BEI increased 26% and 13% for each of these respective scenarios while entropy increased 8% and 14%.

With safety stock, the incidence of inventory errors increased 76% going from three to four levels with information sharing and 68% without information sharing. The BEI increased 16% and the entropy increased 33% in the former scenario (with information sharing) compared to 52% and 16% in the latter scenario. The poor performance for both BEI and entropy likely result from the non-linear fashion that changing the number of levels in a supply chain affects inventory levels.

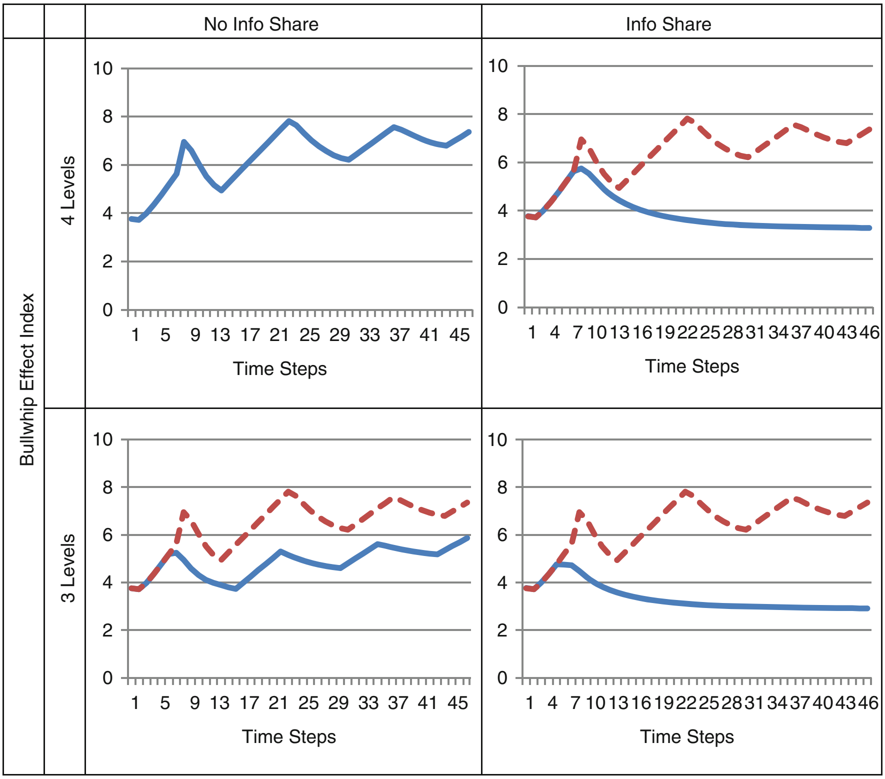

Fig. 5 Bullwhip effect index evolution over time (No safety stock)

5 Conclusions and Future Research

The stated purpose of this study was to explore the utility of supply chain entropy as a means of comparing alternative supply chain strategies and structures. This purpose was motivated by the desire to assess the costs and benefits of increased supply chain complexity. Studying the cost of increased complexity can help answer the question of when to increase use of specialists (thereby adding to the number of supply chain members) and how to coordinate their activities. The underlying assumption of this research is that each product-market scenario requires a different level of supply chain complexity (Narasimhan and Kim 2002), and supply chain managers informed of this relationship can make more intelligent decisions regarding supply chain design. Wal-Mart and the Toyota Production System are examples of firms that developed organizational philosophies and methods to manage complexity across suppliers. Despite the success of the Toyota Production System, the world's largest automobile producer has struggled to bring together the diverse numbers of suppliers required to produce

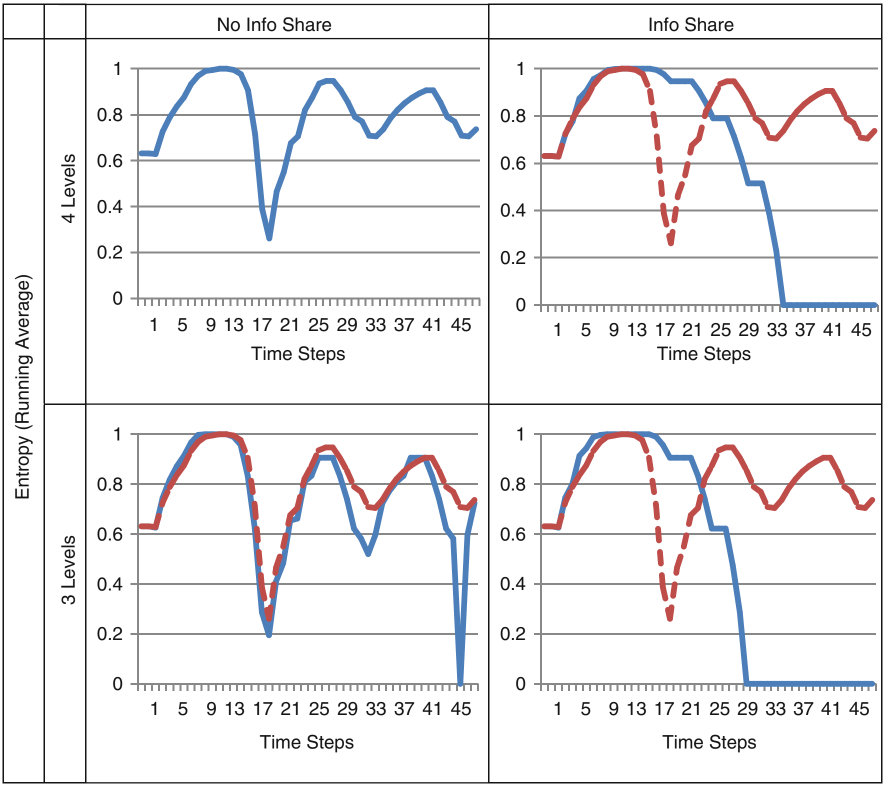

Fig. 6 Running average entropy (No safety stock)

a high quality automobile at the going market price. However, Wal-Mart and Toyota also face costs to manage their suppliers, including information gathering and sharing costs, the costs of maintaining relationships, the cost of production, and the cost of switching suppliers should that become necessary.

This research shed light on the ability of the BEI and entropy as relatively easily calculated measurement tools for determining costs are worth incurring, thereby providing insights for valuing relationships and supply chain strategies, and when to implement changes. This study revealed four principle insights. First, the weighted entropy formulation developed for this study provided a strong measure for how closely the members of a supply chain remained within their stated inventory policy, defined as having no backlogs and minimizing the amount of inventory in excess of the stated safety stock policy. Figure 7 shows scatterplots for the incidence of inventory errors versus entropy and BEI. Entropy demonstrated a correlation of 0.884 with the incidence of inventory errors while BEI demonstrated no appreciable correlation with the actual ability of the supply chain to avoid inventory errors ($r = 0.080$). As a comparison of the variance of the incoming to

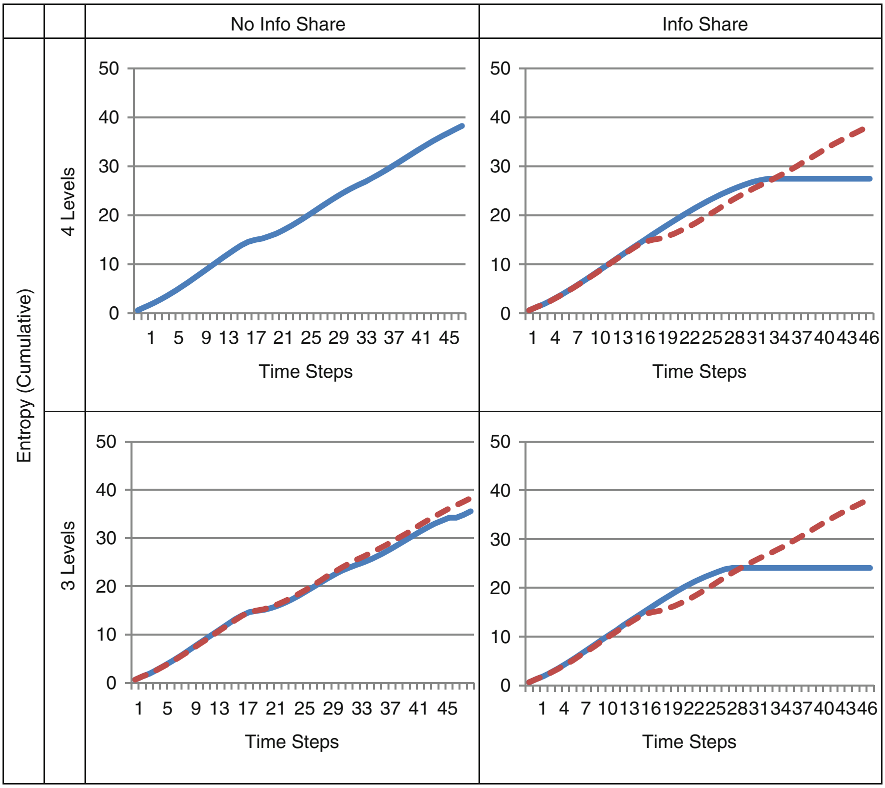

Fig. 7 Cumulative entropy (No safety stock)

the outgoing orders, BEI suffers two problems. One is it's inherit time lag, especially in the case of rapid changes with no information sharing. The other problem with BEI occurs when information sharing allows instantaneous viewing of end consumer demand – the lack of variance in the "step up" demand scenario drives supply chain players to behave as if there were less variance, when in reality the immediate customers in the supply chain sometimes have very different needs from the end market. Additionally, as a measure of variation in orders going out compared to variation in orders coming in, BEI can inflated by demand that varies a lot, even if the supply chain's members succeed in filling the demand.

Second, the weighted entropy measure improved upon the BEI by allowing direct comparisons of the relative effectiveness of adopting different safety stock levels and adopting information sharing. An example of the potential usefulness of this insight can be found in the simulation results for the three level supply chains. The cumulative entropy value of 21.4 for the case of no information sharing and a safety stock of 3 weeks is lower than the 24.0 cumulative entropy for information sharing without safety stock. The BEI scores indicate that the opposite would result

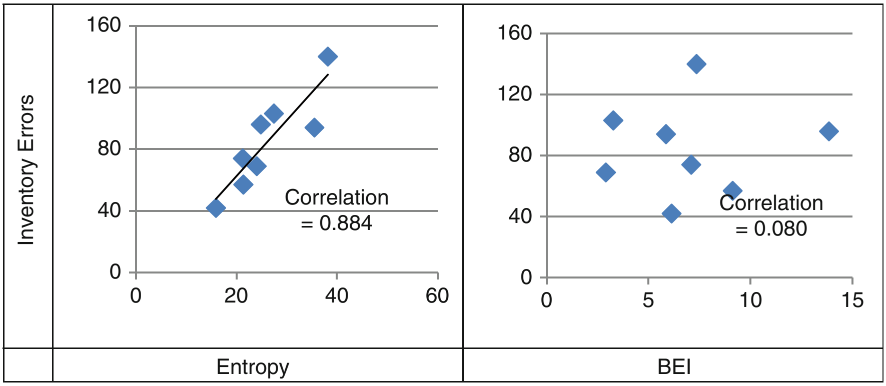

Fig. 8 Correlations of inventory errors versus entropy and BEI

in superior supply chain performance, when in fact the cumulative entropy correctly identified the better scenario based upon the incidence of inventory errors. As long as comparisons are made between supply chains with the same number of echelons, the weighted entropy offered superior capacity for discerning which safety stock and information strategies would reduce the incidence of inventory errors. Unfortunately, despite the weighted entropy's strong correlation with the incidence of inventory errors, it suffers the weakness of not allowing direct comparisons for scenarios of supply chains with different numbers of levels (Fig. 8).

Third, computation requirements for the weighted entropy are relatively low and similar to a weighted moving average forecast. In return for this modest requirement for input, the manager receives an instantaneous indication of whether the supply chain or even just his or her company is synchronized with demand. A little more computation can be used to develop a cumulative entropy chart which offered superior ability to discern when the supply chain operated in harmony with demand patterns.

Fourth, the weighted entropy offered powerful insights into how the supply chain evolved. The BEI provided one global assessment at the end, but often changed little in response to large swings in demand or inventory errors. Entropy provided an easy to read assessment of how often the supply chain operated outside of desired operating parameters, as determined by backlog and safety stock.

Future research should verify the weighted entropy's accuracy under a wider range of supply chain conditions such as differing levels of information sharing and different levels of safety stock. Additionally, real life supply chains may not put the same weight on backorders and overages. Another useful avenue of future research would be to re-formulate the entropy to incorporate different weights or even to reflect the magnitude of overages and backlogs since it currently essentially provides a "yes-no" picture based upon probabilities. Most importantly, the issue of comparing supply chains with different numbers of supply chain members continues to elude the researchers. This remains a question of prime importance.

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Part VI

Value Chain Models: Lean Value Chains

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Leagility in Healthcare: A Start-Up Case Study

Cristina Machado Guimarães and José Crespo de Carvalho

Abstract When taking a broader view, 'leanness' can be conceptualized in terms of a quest for structural flexibility involving restructuring, downsizing and outsourcing. Looking for efficiency, quality and profitability gains, healthcare organizations adopt outsourcing solutions in the attempt of "doing more with less" seeking for benefits such as cost reduction, risk mitigation, adapting to quick changes without compromising internal resources (value mapping and value chain reconstruction) but also taking big risks as loss of control and flexibility. In order to understand how healthcare organizations find the best value equation combining internal and external resources, a case study on a start-up Long-term Care unit with innovative format, great levels of customization and following an outsourcing strategy, was carried out. The main conclusion, among others, is that in ambitious start-ups, when the speed of entrance is a conditioning factor, trade-offs between cost and quality gains (leanness) and between cost and time gains (agility) can be combined through outsourcing strategies in a so called "leagile" paradigm. This study contributes for a wider understanding of the "leagile" concept associated to an outsourcing strategy as a way of coping with market and services volatility, uncertainty and complexity, hyper competition and market share/sped of entrance goals.

Keywords Agility • Lean thinking • Market change • Outsourcing • Risk management • Start-up

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, DOI 10.1007/978-3-7908-2747-7_14, © Springer-Verlag Berlin Heidelberg 2012

1 Introduction

According to some authors (Womack and Jones 1996/2003; Green and May 2005), when taking a broader view, "leanness" can be conceptualized in terms of a quest for structural flexibility involving restructuring, downsizing and outsourcing. The extension (scope), motives (drivers), decision process, contracts, risks and benefits can vary according to each one of the three outsourcing paradigms – transactional, strategic and transformational. In fact this paradigm shift is, according to Kakabadse and Kakabadse (2000) mostly due to the "Westernisation of the Japanese *keiretsu* model" that emphasises flexibility of "lean and mean" structures focused on "core competencies" leading to "do more with less." Do all outsourcing relationships serve lean principles, agile ones, or both?

A decade after Naylor et al. (1999) working paper coining the term "leagility," deeper empirical research in different settings from the usual manufacturing as services, namely in healthcare sector, is still required (Naim and Gosling 2010). Naim and Gosling (2010) literature review shows that the extent to which one paradigm fits into another is in discussion. The scope of each (lean or agile) paradigm and the extent to which leanness is a prerequisite for agility and vice-versa are still contested. Delivering the best value equation to end-customer implies a suitable combination of efficiency, effectiveness and relevancy to face market challenges. In the attempt of eliminate redundant work or find knowledge specialization, outsourcing presents several benefits and continues to drive organizations from vertical to virtual integration (Bowersox et al. 2000).

The main question this research intends to give an answer is: – How to find the best value equation combining internal and external resources in order to quickly turn into, not only a "market qualifier" but also a "market winner" (Christopher and Towill 2000, 2002) offering innovative and highly customized services?

As postulated by Christopher (1997) the competition is not between companies but between supply chains. Thus, organizations core capabilities lie in their ability to design and manage their supply chains in order to have maximum advantage in a continuous changing market (Marcus 2010). In the supply chain management (SCM,[1]) of healthcare organizations, outsourcing decisions have been globally increased. In spite of the differences between healthcare systems, they all are converging into a network governance model where loosely coupled (Orton and Weick 1990) organizations with ever-changing partners are linked by all sorts of outsourcing contracts, not by ownership, in a cooperation atmosphere (Guimarães and Carvalho 2011 forthcoming).

In order to contribute for a wider understanding of the "leagile" concept associated to an outsourcing strategy a case study on a Long Term Care (LTC) unit was carried out. The choice of a LTC was due to the possibility of a longer

[1] Vitasek (2005) definition, consensual among Council of Supply Chain Management Professionals, can be consulted at http://www.cscmp.org/Website/AboutCSCMP/Definitions

evaluation by the end customer of the value equation offered. High innovation and customization levels were also including criteria in order to find evidence of the agile paradigm.

2 Lean, Agile and Leagile Paradigms in Healthcare

In a summarized statement, "leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule," whilst "agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place" (Naylor et al. 1999).

Lean is about doing more with less (Christopher 2011). Presented as an antidote to *muda* (waste), converting *muda* into value, "Lean thinking" was coined by Womack et al. (1990) as a five principle improvement philosophy: (1) specify value, (2) identify the value stream, (3) make the value-creating steps for specific products flow continuously, (4) let the customers pull value from the enterprise, and (5) pursue perfection. Womack et al. (1990) reformulated and streamlined the core lean concepts based in Taiichi Ohno's Toyota Production System (TPS), describing lean production in five elements: (1) lean manufacturing, (2) lean product development, (3) supply chain coordination, (4) customer distribution, and (5) lean enterprise management. Research has been strongly concentrated in lean manufacturing and only recently the discussion on lean production included the concept's relation to Six Sigma and Total Quality Management (TQM) (Liker 2004).

Hines et al. (2004) present the evolution of lean concept highlighting the shifting of focus from quality in early 1990s to customer value with the appliance to services sector, from 2000s onwards. The shifting from manufacturing to services setting is presented by Allway and Corbett (2002). Emiliani (2004), discussed lean practices in higher education and identified outsourcing, technology initiatives and collaboration as the three key methods to reduce cost and improve efficiency in this sector. Also, Piercy and Rich (2009) propose the suitability of basic lean methodologies like value understanding in service context. In 2003 revision, Womack and Jones (1996/2003: 289) introduced the application of Lean thinking in the medical services. Some authors advocate lean practices in healthcare services to eliminate delays, reduce length of stay, repeated encounters, errors and inappropriate procedures (Fillingham 2007; Kollberg et al. 2007; Manos et al. 2006). Souza (2009) updates the lean principles application evolution to healthcare.

The original concept of agility was brought by academics (Lehigh University) and practitioners in 1991 referring to a new manufacturing paradigm (high quality and highly customized products, high information and value added products/ services, mobilization of core competences, responsiveness, response to change and uncertainty and intra/inter-enterprise integration). Based on the first research context – manufacturing – several definitions of Agile Manufacturing were translated into agility for business (Gunasekaran 1998, 1999; Backhouse and Burns 1999; Christopher and Towill 2000; among others) enhancing the organizations' adaptive capability in re-organizing and even in reconfiguring themselves responding to a market opportunity. Gunasekaran (1998) present the key enablers of agile manufacturing to respond to twenty-first century challenges: (1) rapidly changing markets; (2) globalization; (3) decreasing new product time-to-market; (4) increasing inter-enterprise co-operation; (5) interactive value-chain relationships; and (6) increasing value of information/service. One example of the scarce empirical literature on agility is presented by Davies and Drake (2007) contending that to achieve significant improvement in quality, home care service providers must increase agility.

According to Yusuf et al. (1999) definition: "Agility is the successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment." This definition suggests three levels of agility: individual, enterprise and inter-enterprise, supported by four pillars of agile competition: core competence management, virtual enterprise formation, re-configuration capability and knowledge-driven enterprise.

It is useful to underline here that the definition of flexibility as the "ability of companies to respond to a variety of customer requirements which exist within defined constraints" cannot be confounded with agility (Backhouse and Burns 1999).

One of the ways of show re-configuration capability and flexibility is through modularity ("the use of interchangeable units to create product variants" (Ulrich and Tung 1991)), necessary to mass customization, defined as provision of individually customized products (or services) through the use of flexible and highly responsive systems (Pine 1993; Stump and Badurdeen 2009). Sherehiy et al. (2007) review presents: flexibility, responsiveness, speed, culture of change, integration and low complexity, high quality and customized products and mobilization of core competences, as characteristics of agility. In the same tune, Jain et al. (2008) indicate four elements required to an agile supply chain: (1) responsiveness (the ability to identify changes and respond to them quickly, reactively or proactively, and also to recover from them); (2) competency (the ability to efficiently and effectively realize enterprise objectives); (3) flexibility/adaptability (the ability to implement different processes and apply different facilities to achieve the same goals) and (4) quickness/speed (the ability to complete an activity as quickly as possible).

It is unanimous in literature that agile and lean are not synonymous. However, for some, agility is mutual compatible with leanness (Jones et al. 1999; Katayama and Bennett 1999; Naylor et al. 1999; Yusuf et al. 1999; Mason-Jones et al. 2000; Hormozi 2001), as lean is needed to build agility (Marcus 2010). Containing "little fat," leanness may be an element of agility, but by itself does not warrantee satisfying the customer more rapidly as is expected from a "nimble" organization (Christopher 2011). Naylor et al. (1999) posit that both lean and agile systems emphasize supply integration, waste reduction, and lead time compression, but they differ mostly in their emphasis on flexibility for market responsiveness.

For Krishnamurthy and Yauch (2007) lean is more related with production focused while agile is with customer focused strategies. Gunasekaran and Yusuf (2002) stated that when the primary goal is to be lean, responsiveness is compromised over cost-efficiencies whilst agility places cost and responsiveness as equally important.

For Narasimhan et al. (2006) lean does not imply agile, but agile does imply that many of the principles and techniques of lean are in place. The Total Cycle Time Compression Paradigm (Towill 1996) is, though, sufficient to achieve lean, but represents only one necessary condition, not sufficient, to achieve agile (Christopher 2002). Therefore, agile is a post-lean paradigm leaving to lean a "foundational" role.

Some authors (Cox and Chicksand 2005; Herer et al. 2002) find the agile paradigm suitable to innovative products, in low volume, highly volatile supply chains, where customer requirements are often unpredictable and supplier capabilities and innovations are difficult to control as in healthcare services. Others (Mason-Jones et al. 2000) compare both paradigms distinguishing attributes, but in the end of the day, the essence of the difference lies, in terms of value to the customer, in the fact that in agility, the market winner is service level, whilst cost is the lean critical factor (Christopher and Towill 2000).

"Leagility" (Naylor et al. 1999; Mason-Jones et al. 2000; van Hoek 2000) is the combination of both paradigms (lean and agile) within a total supply chain strategy marked by a decoupling point downstream of which an agile strategy responds to a volatile, unpredictable demand, and upstream providing level scheduling and eliminating waist, non-added-value activities and bottlenecks pursuing a lean strategy. This strategic point separates the supply chain part that is pulled directly by the end customer and where variability asks for agility and effectiveness, from the upstream supply chain part lead by efficiency purposes and forecast driven. Leagility is, thus, also called hybrid strategy (Christopher 2011). Both paradigms can coexist separated: (1) by space (matching agile supply chain with innovative products and functional products); (2) within a whole and its parts (by settling a decoupling point); (3) in time (having short lead times for "fashion" or "emergency" and longer ones for "basics" or "elective"); and (4) upon condition (using order winner criteria in market segmentation or in product design modularization) (Stratton and Warburton 2003). According to Towill and Christopher (2005) "having the best of both worlds" is also possible in healthcare setting through a "pipeline differentiation," coexisting lean and agile pipelines, or by using three approaches: (1) the Pareto curve approach; (2) the decoupling point; and (3) the "base and surge" demands.

It is also possible for a corporation to simultaneously pursue both lean and agile strategies by adopting a leagile infrastructure (Krishnamurthy and Yauch 2007). Naim and Gosling (2010) review stresses that lean, agile and leagile systems may be implemented according to product type and phase of its life cycle. Standard/ functional products or commodities (Fisher 1997) call for lean systems and hybrid products call for leagile systems, no matter the cycle life phase they're in. Conversely, innovative products first two cycle life phases (infancy and growth) ask for agile systems, while in maturity and decline phases they can have either lean or leagile systems.

Also, leagility enables "mass customization" strategies by turning offer variety stable and flow responsive (van Hoek 2000). The shifting from craft industry to a process industry in healthcare sector (Bliss 2009), where guidelines don't jeopardize individual different care, introduces a mass customization paradox that lead to combine lean with agile paradigm (Krishnamurthy and Yauch 2007).

3 Leagile Outsourcing

Outsourcing or transferring internal activities to third parties (Greaver 1999) can assume several forms in a wide spectrum of relationships (Ballou 2003: 716; Franceschini and Galetto 2003; Sanders et al. 2007). A theoretical evolution from Transaction-cost Analysis (TCA) and Agency theory (AT), to Resource-Based View (RBV), and, more recently, to the Transformational View placing outsourcing as a SCM strategic tool able to redesign the organization value chain and, sometimes, its mission (Schneller and Smeltzer 2006), can be summarized in Table 1.

Healthcare organizations adopt outsourcing solutions for the same reasons as in other sectors (Quinn and Hilmer 1994), looking for efficiency, quality and profitability gains. However, in healthcare units, outsourcing is sometimes part of volume flexible strategies trying to respond to non-predictable demand flotations, care increasing complexity, and to the linkage between clinical performance and act volume (Jack and Powers 2006). In fact, according to some authors (Atun 2006; Campos 2004), outsourcing of clinical services was a response to waiting lists. From reviewing the literature, the most pointed drivers to outsource in healthcare units are: (1) cost reduction; (2) risk mitigation; (3) adapting to quick changes without jeopardize internal resources; and (4) value stream redefining (Alper 2004; Bhattacharya et al. 2003; Chen and Perry 2003; Hazelwood et al. 2005; Lorence and Spink 2004; Roberts 2001; Wholey et al. 2001; Yang and Huang 2000). Outsourcing decisions in healthcare units also depend on: (1) the kind of activity (modular versus integral more or less contractible); (2) the type of contract (classical versus relational); (3) contract duration (depending on contract type and supplier selection process); (4) specification of performance requirements (process and outcomes indicators) and, finally (5) payment mechanisms (Liu et al. 2004).

However, not every outsourcing strategy leads to cost reduction. Apart from non-successful outsourcing experiences, where hidden costs (monitoring, contract management, low productivity and high turnover (Kremic et al. 2006)) erase the initial cost advantage, in successful *transformational outsourcing*, according to Linder (2004b), when comparing internal with external costs, in the four phases of organizations life cycle, only in the last two phases outsourcing leads to cost reduction. In start-up phase, external costs are, according to this author, higher than internal and in the "Pathway to Grow" phase, the costs of outsourced services are equal to internal cots, not showing advantages of cost reduction.

Table 1 Outsourcing – paradigm shifting

Issues	Transactional outsourcing (1970s and 1980s)	Strategic outsourcing (since the 1990s)	Transformational outsourcing (twenty-first century)
Theoretical background	TCA	RBV	Relational view
	AT		Network theory
Decision drivers	Cost (production and transaction) reduction strategies	Differentiation strategies	Mixed strategies (supply chain extended)
	Functional specialization	Market adaptation	Reinvent the business
	Competitive needs	Competitive advantages	
Kind of activities	Non core activities	Core and non-core activities	Complete process (BPO – Business process outsourcing)
	"Problematic" functions	Set of activities	
	Single function	Multi-function	
Kind of agreements	Cost/efficiency evaluation	Value complementary evaluation	Value creation evaluation
	Decision based on price and, margin bargain	Decision centred in tangible, no tangible and profit share	Alliances and partnerships
	Short term (up to 3 years)	Long term (3–7 years)	Cooperative relationship (10–15 years)
	Agent–principal relationship	Synchronized relationships	Virtual outsourcer (net or service's clusters)
	Individual outsourcer	Multiple vendors	

Based in: Bettis et al. (1992), Brown and Wilson (2005), Coase (1988), Conner and Prahalad (1996), Eisenhardt (1989), Ford (1990), Franceschini and Galetto (2003), Grandori (1997), Kakabadse and Kakabadse (2000, 2003, 2005), Kelley (1995), Kulkarni and Heriot (1999), Lacity et al. (1995), Lee et al. (2000), Linder (2004, 2004a, b), Liu (2007), Lonsdale and Cox (1997), Madhok (2002), Mowery et al. (1998), Mullin (1996), Peisch (1995), Prahalad and Hamel (1990), Quinn (2000), Quinn and Hilmer (1994), Sanders et al. (2007), Williamson (1979)

Still, "make or buy" decisions are taken according to a core competencies evaluation. Core competencies can be pooled to reduce time to market (Gunasekaran 1998). The meaning of core in health care organizations is defined in Young (2007, 2007a) as "direct contact with patient."

The Virtual Enterprise (VE) or the integration of core competences distributed among a number of real and carefully selected organizations, can be used as loose coupling mechanism of integration promoting agility. In this "sub-strategy," temporary alliances and partnerships based on core competencies are formed to improve flexibility and responsiveness (Gunasekaran 1999). Based on this view in which success lies on focusing in the activities with a differential advantage over competitors (Resource Based View – RBV), outsourcing the remaining activities leads to creation of "network organization," confederations of firms linked through shared information and aligned processes (Christopher 2011). This author stresses the need of a responsive organization facing the continuous and rapid changes, a "new organizational paradigm" that combines innovation and flexibility with co-operation in competition (co-opetition). This virtual integration requires, as stated by Bowersox et al. (2000), monitoring supplier performance skills, common vision of value creation among all supply chain partners in a risk/reward sharing atmosphere, and also extending Lean management views beyond suppliers achieving up-stream alignment.

According to Green and May (2005), the legitimacy of Lean discourse is rooted in 30-year trends of corporate restructuring, de-layering and outsourcing. In the attempt of "doing more with less," outsourcing presents several benefits such as cost reduction, risk mitigation, adapting to quick changes without compromising internal resources (value mapping and value chain reconstruction) (Roberts 2001; Hazelwood et al. 2005), but also big risks as loss of control and flexibility (Lonsdale and Cox 1997; Chasin et al. 2007).

So, outsourcing seams to follow not only Lean paradigm, with a strong focus on reducing waist (sometimes mainly costs) but also agile, pursuing flexibility and quick response – but when can we call it a leagile outsourcing?

Taking the logistics management three dimensions as decisional tool (Fig. 1) and the dominant thinking in the literature, one can posit that Lean focus mostly on cost and quality.

However, Lean supply chain impacts flexibility and time-based technology leadership objectives rather than cost and quality. Conversely, the agile supply chain influenced cost rather than flexibility and time-based technology leadership (Yusuf et al. 2004).

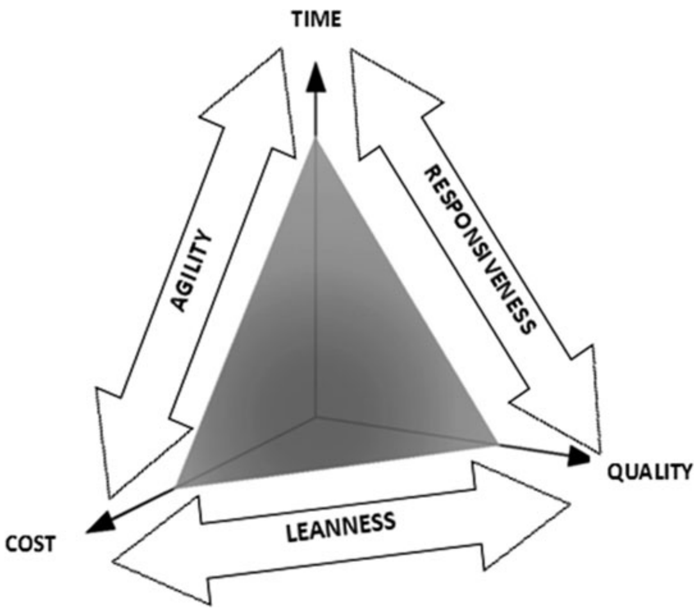

Fig. 1 Logistical triad (Adapted from Carvalho and Ramos 2009)

In terms of performance outcomes, according to Cagliano et al. (2004), there is no clear evidence (in manufacturing setting) of the dominance of one supply model on the other.

Combining both paradigms leads to focus on time and quality pursuing responsiveness goals. That is the focus of a start-up outsourcing strategy.

4 Methodology

According to Yin (2009), case study method is appropriate to “How” and “Why” questions and to investigate a contemporary phenomenon in its real-life context when the boundaries between phenomenon and context are not evident recurring to several data collection techniques and different evidence sources. This qualitative method, allowing a deeper understanding of phenomena (Flyvbjerg 2006), has been frequently used in management studies, namely in operational management (Voss et al. 2002) and logistics (Ellram 1996; Renner and Palmer 1999). Being more an idiosyncratic than a generalizing method, was chosen by its descriptive and exploratory character, not to produce causality statements but to achieve a logical sequence of connection between empirical data, problem/research questions and findings/conclusions. Though, the unit of analysis chosen was a start-up geriatric Long-term Care unit with recognizable innovative format (grate customization levels and distinctive service offer compared to other players).

As recommended by Yin (2009) in data collection and analysis, a study protocol was followed as well as multiple sources data triangulation. For data collection (from April to October 2008) we’ve recurred to semi-structured interviews (to the CEO, COO, Marketing Director, one external consultant and three department managers), document analysis (company profile, interim regulation, outsourcing proposals, contracts, sector regulations, internal memos, structural charts, press releases) and direct, non-participant observation (procedures of outsourced activities) (Saunders et al. 2007). Data analysis followed Miles and Huberman (1994) recommendations on data codification, reduction and categorization techniques. Data gathered from different informants and sources was reduced to precise categories in common tables (Miles and Huberman 1994), and then systematically interrogated (Yin 2009) comparing and noting patterns (Miles and Huberman 1994).

The results were compared with an on-going review of the concepts’ attributes of each paradigm and their linkage to the option of outsourcing in a start-up phase.

5 Long-Term Care Start-up Case

CL is the first unit (two other are in project phase) of an organization that aims to be a national reference in providing high quality and differentiated Long-Term care for the elderly. Having a market share penetration ambitious goal of 15–20% in 7–9 years, CL aims to be the first, the better and the bigger player among others on The long-term care scene. In a moment marked by the announced entrance of several players in this fast growing sub-sector, this unit is the only one presenting a floor building segmentation by independency levels. An interdisciplinary care plan for each client and a specific place in the residence is given as result from a complete geriatric assessment, by a multi-professional team, at check-in time and during follow-up to match the particular needs of each person. Therapies, equipment, medication, leisure actions and even meals are customized in a four star hotel environment. Though, in client's value equation four major issues are addressed: (1) clients expectations (cleanness, safety, comfort and health solutions); (2) modular solutions (rehabilitation, maintenance, prevention); (3) service delivery (specialized, customized); and (4) service segmentation (price, range).

According to the interviewees, outsourcing was consider, first of all, due to strategic need for flexibility, time scarcity, speed to enter in the market and focus in core business. To outsource expertise, specific know-how to deal with complexity of some non-core activities were the main purposes, leaving financial worries to a second plan. As restrains of outsourcing decision we found: (1) an adversity to take risks from the top management that takes outsourcing as a risk mitigation way; (2) an ambition of market leadership; (3) a best-in-class seeking position in the Long-Term care business; (4) an innovative combined health-hotel service; (5) all service components are modular "same ingredients are used for different recipes"; (6) the rule of service delivery to final client only by in-house staff; and (7) incipient degree of knowledge formalization with no reporting culture and few written procedures.

Recurring to Porter's value chain model, all activities in shade ground are outsourced (Fig. 2).

From all support activities, only procurement and client's personal laundry (with high risk of loss or mix up) are kept internal. All primary activities, being a direct service to final client, are kept internal. Were chosen to outsource the activities: (1) less specific, having similar competitors in the market; (2) less complex, simplifying the Requests For Proposals (RFP); (3) with broader scopes and, though, with no punctual periodicity; (4) with medium level of criticality as, even non-core

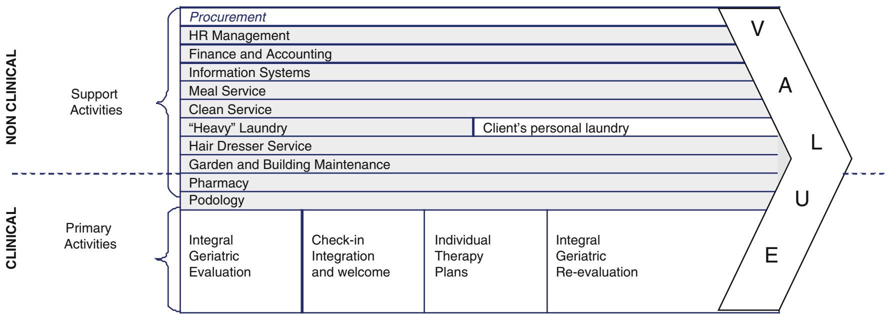

Fig. 2 CL value chain

activities (meal and laundry services) are very “visible” or close to final client; but having always as rule to outsource activities (5) not direct delivered to final client. All contracts are for one year period, with a classical structure with no mention to contingence measures for failures or penalties and monitoring system.

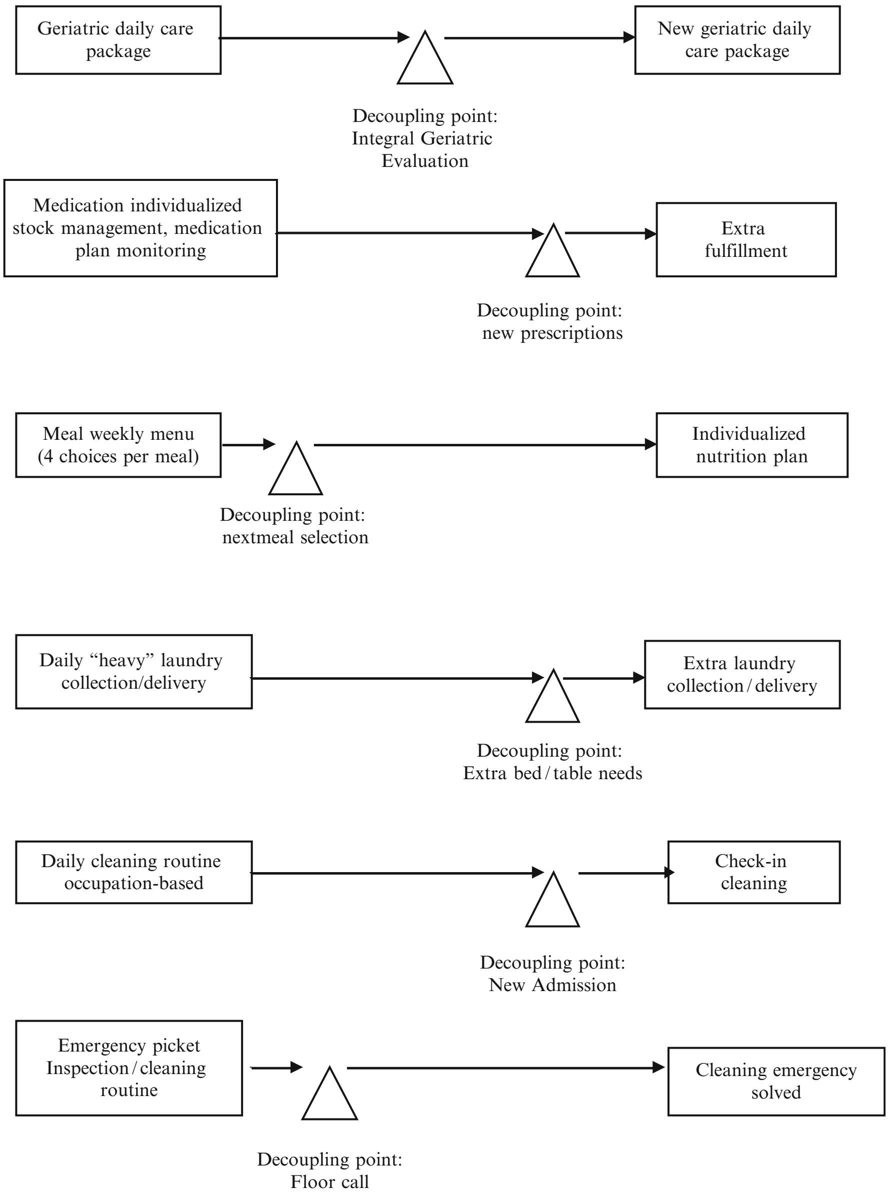

Fig. 3 Activities decoupling points

Table 2 Lean, agile and leagile paradigms distinguishing attributes

Attributes	L – Lean paradigm	A – Agile paradigm	LA – Leagile paradigm	Case findings
Quality	Market qualifier	Market qualifier	Market qualifier	LA
Cost	Market winner	Market qualifier	Market winner	LA
Lead-time	Market qualifier	Market qualifier	Market qualifier	LA
Service level	Market qualifier	Market winner	Market winner	LA
Customization	Low	High	Moderate	LA[a]
Market demand	Predictable	Volatile	Volatile and Unpredictable	LA
Service variety	Low	High	Medium	LA
Service life cycle	Long	Short	Short	L
Service type	Elective	Emergency	Both	LA
Customer drivers	Cost	Lead-time & Availability	Service level	LA
Profit margin	Low	High	Moderate	LA
Dominant costs	Physical costs	Marketability costs	Both	LA
Lead time compression	Essential	Essential	Desirable	LA
Rapid reconfiguration	Desirable	Essential	Essential	LA[b]
Eliminate *muda*	Essential	Desirable	Arbitrary	A[c]
Robustness	Arbitrary	Essential	Desirable	LA

[a]Mass customization,
[b]Modularity,
[c]Time wastes, mostly
Based in Agarwal et al. (2006)

The daily based outsourced activities (geriatric care, pharmacy service, meals service, laundry and cleaning services) were analysed following the tree paradigm (Lean, Agile and Leagile) theoretical perspective. and found each decoupling point separating the "pull" system from the "push" as presented in Fig. 3.

For having missed some steps on outsourcing process and lacking risk assessment before the final outsourcing agreement, CL and vendors went on a spiral of continuous revisions and processes redesigning leading to service discontinuity and loss of quality. Also, the adjustment process resulted in higher costs (external consultancy, internal and external training programs), extra-time spent (designing and testing new processes, new contracts and negotiation), quality problems revealed in clients surveys, and lack of flexibility to follow occupation rates changes.

Nevertheless, based in the literature review, it was possible to find evidence of each paradigm's attributes as presented in Table 2.

6 Conclusions

In ambitious start-ups, when the speed of entrance is a conditioning factor and a main concern, trade-offs between cost and quality gains (leanness) and between cost and time gains (agility) can be combined through outsourcing strategies in a so called "leagile" paradigm. The reported case is an example of the Lean goals existence in the make or buy rational – to externalize all non-core activities (what is not directed delivered to the customer) in order to deliver a quality service with less costs (non-core competences development and other investments). At the same time we can find agile purposes due to time pressure that led to some supplier choices based on the lowest bid and in the constant references to flexibility gains from interviewees.

Also, in spite of being the lean philosophy that leads a start-up healthcare organization to outsource "non-value" added activities in order to gain speed to market and flexibility in entrance momentum, innovative products first two cycle life phases (infancy and growth) ask for agile systems. It is, therefore, suitable to combine both characteristics, agile and lean, in order to be able to achieve the required degree of responsiveness that places the organization as a "market winner" by offering an innovative service at a competitive price. The case presents the combination of both paradigms not only in the rational of outsourcing decision but also in the architecture of each (internal or externalized) service. The modularization of services (and spaces) and the stream dual philosophies allowed the existence of decoupling points, boundaries between lean and agile systems.

The inclusion criteria of being an LTC unit, where the length of staying is bigger than in other healthcare units, allowed to study a longer customer evaluation of the value equation. The focus on customer gives emphasis to the statement: "This year's market winner is next year's market qualifier (Christopher and Towill 2000). An organization can be fat and nimble. . .but not all the time. Sustainability issues were not taken into consideration in all outsourcing processes in CL case.

This paper provides an example of "leagile" concept associated to an outsourcing strategy in healthcare setting showing the decoupling points in primary and support activities.

Therefore, this study contributes for a wider understanding of the "leagile" concept associated to an outsourcing strategy as a way of coping with market and services volatility, uncertainty and complexity, hyper competition and market share/sped of entrance goals.

In spite of being supported by a single case study, the paths followed in the structure of this study enables replication in other units of analysis with similar inclusion criteria.

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Lean Production in Austrian Industrial Companies: An Empirical Investigation

Christian Neumann, Sabrina Kohlhuber, and Sabine Hanusch

Abstract Due to the recent worldwide recession companies again tend to focus on cost-efficiency by increasing the ratio of value adding activities within their intra- and inter-organizational processes. In order to achieve efficient processes and eliminate non-value adding activities out of customers' perspective, the principles and methods of Lean Production (LP) are gaining interest especially in Austrian companies. According to this development the need of further lean-activities within the Austrian industry can be deduced but not validated. Due to this fact the purpose of this paper is to survey and discuss the status quo of Lean Production in Austrian companies. Therefore three different perspectives are used to describe the actual situation of lean-paradigm within the industry. These are the currently applied principles and methods as well as their degree of implementation, the acceptance of implementation and the structural/organizational integration. Furthermore a trend of the prevalence and application is predicted due to the degree of implementation and the prospective requirements. In summary it can be stated that LP is already known and applied in Austrian industry. However, the need of further activities to intensify the application of lean methods can be deduced. In this context it seems important that there is still resistance to implementation offered from the foreman and the operators in general. Therefore, the involvement of the employees before and during the implementation process can be defined as one important critical success factor of LP.

Keywords Austrian industry • Future implications • Lean production empirical study • Methods • Principles

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, DOI 10.1007/978-3-7908-2747-7_15, © Springer-Verlag Berlin Heidelberg 2012

1 Introduction

Initiated by the latest economic recession companies tend to focus on cost-efficiency concerning their intra- and inter-organizational processes (Lange and Kippels 2010; Singh et al. 2009). According to Monden (1993, Hines and Rich 1997) processes in general and – in this context – especially production processes consist of value-adding (VA), non-value-adding (NVA) and necessary but non-value adding (NNVA) activities whereas the value can only be defined by the customer (Womack and Jones 1996). Therefore, the elimination of NVA and furthermore the NNVA is one common approach to increase the efficiency of intra- and inter-organizational processes (Monden 1993; Hines and Rich 1997; Seth and Gupta 2005; Bell 2006). Thereby the percentage of VA to NVA and NNVA activities concerning the production lead time can be one indicator for efficient processes (Klevers 2007). Due to the fact that the NVA and NNVA activities require in average about 90% of the production lead time in Western European companies, there is potential for improvement (Neumann and Hanusch 2010).

One concept to achieve such improvement is Lean Production (LP) that ensures the focus of all production processes to the value chain (Stroh 2009). Especially in Austrian industrial companies the principles and methods of LP are gaining interest in order to optimize the production processes. This opinion is reflected by the rising number of lean-projects, as the latest experiences of the authors have shown. This trend is not only limited to Austria because German literature also discusses this topic extensively. For example Faust (2009) initiated the term *2. Welle Lean*, which means second lean-hype and indicates the on-going relevance of Lean Production and management for industries.

According to this development the need of further lean-activities within the Austrian industry can be deduced but not validated. Due to this fact the main purpose of this paper is to survey and discuss the status quo of Lean Production in Austrian companies. Furthermore, additional practical fields of research concerning LP in Austrian companies are deduced by exploring the trend of the prevalence and application due to the degree of implementation and the prospective requirements. Therefore, three different perspectives are used to describe the actual situation of lean-paradigm within the industry.

The first perspectives are currently applied principals and methods of LP as well as the degree of their implementation. According to Liker (2004) the increase of VA activities can only be achieved by implementing and applying different principles and methods of LP.

However, to apply the principles and methods successfully within the company, it is necessary to involve each employee in all phases of implementation. Additionally, they have to be motivated to internalize the lean culture and strive for continuous improvement. Under this premise the acceptance of the employees can be defined as one important critical success factor in order to implement and run the principles and methods of Lean Production effectively (Drew et al. 2005). Consequently, the second perspective is the acceptance of implementation.

Finally, Brunner (2008) stated it is important to establish an organizational integration of lean production in the company. He advises to define clear objectives and review the compliance of them regularly to take countermeasures in case of non-compliance or deviations from the defined objectives. According to this, the third and final perspective is the organizational integration of LP in the company.

To sum up, the three perspectives of the investigation are the currently applied principles and methods, the degree as well as the acceptance of implementation and the organizational integration. Furthermore a trend of the prevalence and application is predicted according to the degree of implementation and the prospective requirements.

In order to meet the purpose of the paper two complemented research methods are used. Up to now principles, aims and methods of Lean Production are not consistently defined and described in literature (e.g. Pettersen 2009). Therefore a literature review was done in order to figure out the most important methods of Lean Production and to separate them systematically from existing aims and principles. As a basic framework for this approach the Toyota Production System-House (TPS) based on Liker's research (2004) was used. Based on this framework the results of the literature review were summarized and allocated to the different elements of the TPS-House.

After the literature research, the authors did an empirical survey within Austrian companies according to the purpose of the paper. The major part of the study was based on a repeatedly used questionnaire in the automotive industry in Germany. This questionnaire was further developed, keeping with the results of the literature review, and additionally adapted to meet the requirements of the manufacturing industry in general.

Due to the background of the paper, which is the analysis of the status quo of LP, descriptive statistics were used to elaborate on the current situation in Austrian industrial companies. Furthermore, the results were explored to define additional fields of research concerning LP and to deduce empirically based hypotheses for the improvement of the inter- and intra-organizational value chain.

To meet the aims and delineated requirements of the paper, the main part comprises two essential parts. Firstly, the applied research methods are introduced and discussed in detail. Additionally, the results out of the literature research, which is a basis for the development of the questionnaire, are presented. The second part elaborates on the results from the empirical investigation concerning the status quo of LP in Austrian industrial companies. Furthermore, the collected data and information is analyzed and relevant findings concerning the management of value chain are deduced in order to optimize the intra- and inter-organizational processes. Finally, the key findings out of the survey were summarized and consolidated into managerial insights.

2 Applied Research Methods

As stated in the introduction, Lean Production pursues certain goals which can be achieved by using different principles and methods (Liker 2004). There are a number of authors who elaborate on the field of Lean Production but often treat different aspects (Table 1). The connection and boundary between the objectives, principles and methods of LP is not clearly defined. To separate them clearly from

Table 1 Literature research: goals, principles, methods of LP

Authors	Goals	Principles	Methods
Baudzus et al. (2009)	Low costs, high delivery reliability, high quality	Perfection, process orientation, pull principle	5s, Andon, Heijunka, Kaizen, Kanban, Milk Run, Poka Yoke, Ship to line, SMED, standardized key figures, teamwork, TPM, TQM, value stream mapping
Brunner (2008)	Low cycle times, low costs, high quality	Flow principle, pull principle, value, value stream	5s, 5 Why's, Andon, FMEA, Heijunka, Kaizen, Kanban, employee sample, employee training, One-Piece-Flow, Poka Yoke, SMED, standardization, standardize key figures, teamwork, TPM, TQM, value stream mapping
Gienke and Kämpf (2007)	Low costs, high moral, high quality	Flow principle, perfection, pull principle	Andon, Kaizen, Kanban, Poka Yoke, Quality Circle
Drew et al. (2005)	Low costs, high quality, high security, high reliability	Flow principle, perfection, pull principle, value, value stream	5s, Andon, Heijunka, Kanban, One-Piece-Flow, SMED, standardization, standardized key figures, teamwork, TPM, TQM, value stream mapping
Westkämper (2005)	Low costs, high quality	Flow principle, perfection, pull principle, value	Andon, FMEA, Kaizen, Kanban, teamwork, TPM, TQM, value stream mapping
Liker (2004)	Low costs, high moral, high quality, high security, low cycle times	Flow principle, perfection, pull principle, value, value stream	5 Why's, Andon, FMEA, Genchi Gembutsu, Heijunka, Kanban, Nemawashi, determination of decisions, Poka Yoke, Ringi determination of decision, standardization, TQM
Womack and Jones (1996)	Low costs, low cycle times, high quality	Flow principle, perfection, pull principle, value, value stream	5s, Andon, Heijunka, Kaizen, Kanban, Poka Yoke, SMED, standardization, teamwork, TPM, TQM, value stream mapping
Ohno (1993)	Low costs	Flow principle, pull principle, value stream	5 Why's, Heijunka, Kanban, One-Piece-Flow, standardization, teamwork, TPM, value stream mapping

each other, a literature research was done as mentioned before. Table 1 shows the different authors and their individual perspective on the principles, methods and objectives of LP.

Whereas the principals are defined relatively clearly, based on the work of Womack and Jones (1996), the scope of methods differs. The main reason why there is a difference is related to how the authors define terms and analyse the methods. An example would be that the quality circle could be a method by itself or defined as a part of TQM. Due to this fact a clustering of the methods was done in order to achieve the highest useful level of aggregation for the survey. According to these results the TPS-House (Liker 2004) was adapted (Fig. 1) which provides a useful framework for LP in the current paper.

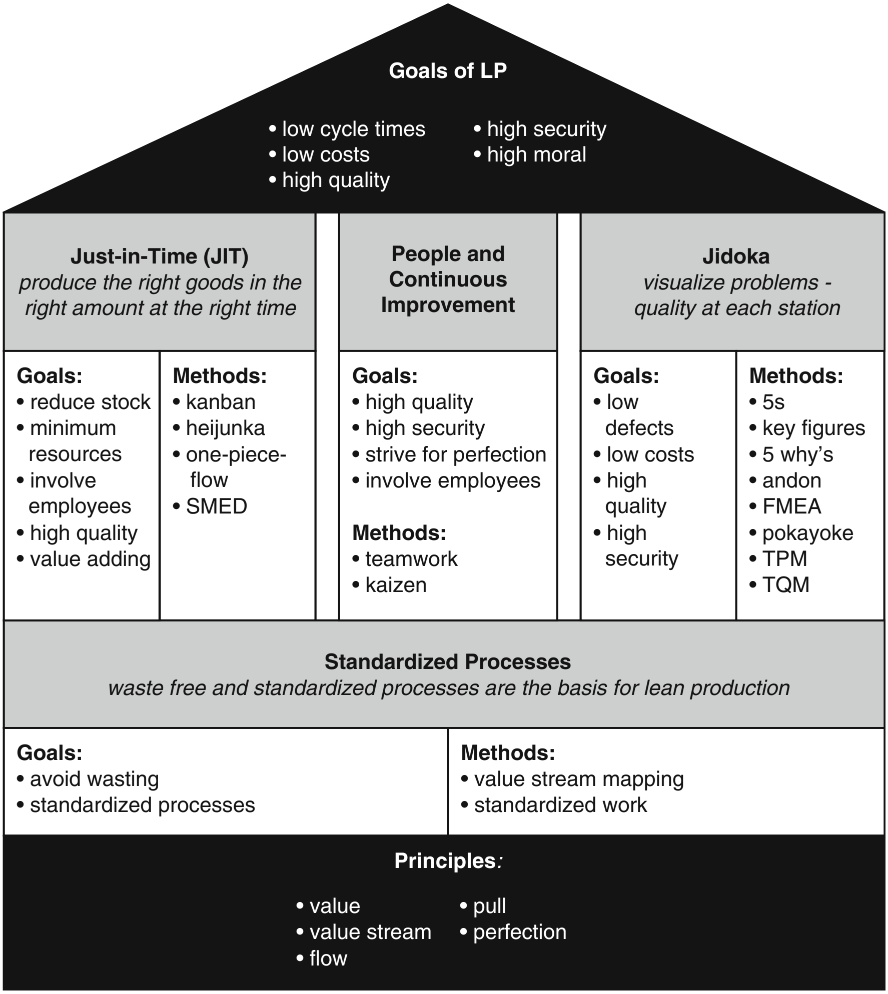

Fig. 1 The adapted TPS-House according to Liker (2004)

Pettersen (2009) published similar results from a literature research which could be an additional validation of the authors' results. The difference of the two papers consists mainly of Petersen's wider focus. While the current literature review focuses on methods, Pettersen listed characteristics and terms which are widely associated with lean in order to define LP and differentiates it from other management concepts. Furthermore he did not systematize his results within a framework like the TPS- house. Rather, he sorted the characteristics how often the terms were used and grouped those in collective terms.

The results from the literature review were integrated into existing questionnaire and supported the perspective of applied principles and methods of LP concerning the survey. Figure 1 shows the enhanced TPS-House with its different elements. In the upper segment, which the roof, the goals are presented. The basic goals of lean manufacturing are high quality, low costs, low throughput, high security and morale of employees. The basement consists of two stages. In the first level the principles value, value stream, flow, pull and perfection are contained. The second stage consists of solid and standardized processes. The heart of Lean Production consists of the people and the striving for continuous improvement. The pillars on the sides include Just-in-Time (JIT) on the left and Jidoka on the right. The house, as a basic structure, visualizes the context of the various principles and methods. Without the basement, the heart and the pillars, the roof would not be supported and the objectives could not be achieved. This should illustrate that the goals of Lean Production can only be reached if the principles and methods are applied holistically (Brunner 2008).

To elevate the status quo of Lean Production in Austrian companies, a study was conducted. Generally, it can be distinguished between an interview and a questionnaire. Each method has its advantages and disadvantages. Essential criteria that were crucial for the survey method are the large sample size, the bias of the results and the evaluation effort. The method of the questionnaire comes up with these criteria rather than an interview.

The development of the questionnaire is divided into three steps. These steps are the preparation, the planning and the construction (Kirchhoff et al. 2008; Moosbrugger and Kelava 2008).

The preparation step includes the definition of the main questions of the survey in order to get the useful answers, which can be analysed as well as research for existing studies concerning Lean Production (Kirchhoff et al. 2008). The German company Agamus Consult provides a survey about Lean Production in the automotive sector. Agamus Consult does this survey every year successfully, which allows the authors to assume that the company has an appropriate know-how in creating a questionnaire. During the review of the questionnaire the main contents were noted as useful for the purpose to obtain the status quo of LP in Austrian companies.

By reviewing the questionnaire the authors came to the conclusion that the questionnaire of Agamus Consult provides a good basis, although there would have to be adjustments. Specifically, the existing survey just investigates the automotive sector. The structure also had to be changed because goals, principles and methods of Lean Production were mixed.

The next step after preparation is the planning. In this step the target group, the population and the survey method have to be defined. As production engineers have the most know-how about existing processes, they were defined as the target group. According to Zöfel (2002) the population includes all accessible individuals that show a common property. Based on this definition all manufacturing Austrian companies with more than nine employees and a valid e-mail-address were set as the population. The constraint of nine employees arises out of the assumption that companies with nine or less employees do not have the financial possibility or even the requirement to implement LP. The necessary data were provided by a marketing database of the Austrian branch-register Herold. Due to the fact, that this database does not provide all contact addresses of the existing manufacturing Austrian industrial companies, it is not possible to suggest recommendations based on the results of the survey to all companies. Therefore, it was not necessary to draw a random sample on the addresses and so all contacts of the population were invited to join the study.

The next step was the definition of the survey-method. For the survey of the status quo of Lean Production in Austrian companies, the web-based survey tool LimeSurvey was used.

The construction step includes the determination of the structural design, the choice of question types, the correct wording of the questions, the choice of the scales, the pre-test and the verification of the criteria objectivity, reliability and validity.

The questionnaire was structured into four parts. These are the structural data of the company, the used principles and methods, information concerning the implementation of Lean Production and the organizational approach. In summary, the questionnaire includes 29 main questions and 17 additional questions which appear by choosing the field "other."

After the structuring of the questionnaire, the question types had to be defined. Questions can be differentiated in closed, open-ended and semi-open-ended questions (Porst 2009). Mostly closed questions were used because they are easier to evaluate and the possibilities of the different answers were known due to literature research and the questionnaire of Agamus Consult. Also, semi-open-ended questions were in use wherever the number of possible answers was too high.

Besides the question types, it is important to find the correct wording of the questions and to define the used scales. The questions should not be too long or ambiguous and vague terms should be defined (Porst 2009). Some questions were readily adopted one by one and some ones had to be adapted to clarify ambiguous terms referring to the know-how of the target group. Scales can be differentiated in nominal, ordinal, interval and ratio scales (Porst 2009). For this survey nominal and ordinal scales were used.

After the generation of the questionnaire, a pre-test was conducted to check the logic, accuracy and consistency of the questionnaire, as Kirchhoff et al. (2008)

suggested. Therefore, 16 persons with different know-how about Lean Production answered and evaluated the questionnaire. With these results the survey was revised.

The next step after the pre-test includes the verification of the criteria objectivity, reliability and validity.

The objectivity is the independency from subjective or external influences concerning the accomplishment, the evaluation and interpretation of the survey. In case of a questionnaire, the respondents are not influenced by the interviewer, so the objectivity of the accomplishment is obtained. Each answer received a numerical value so each person who evaluates the answers will receive the same results. Therefore, the objectivity of evaluation is gained, although a small degree of subjectivity is not excludible. Nonetheless with the numerical values of each answer the subjectivity is very low (Moosbrugger and Kelava 2008).

The reliability is the measurement without measurement errors. A questionnaire is reliable if it provides the same results by repeating the survey under the same conditions (Moosbrugger and Kelava 2008). To verify this, the Split-half method was used. Therefore certain questions have been asked several times in different ways to verify the "correctness" of the results.

A questionnaire is valid if it measures exactly the content it should measure. It is the most important criteria because a questionnaire can only be valid if the fulfilment of objectivity and reliability is acquired (Schnell et al. 2008). In general, there are four types in which validity is divided. These are the content, the appearance, construct and criteria validity (Moosbrugger and Kelava 2008).

The content of the generated questionnaire was compared with the content of the approved questionnaire of the German company Agamus Consult, so the content validity is obtained. Because of the positive feedback of the participants, the appearance validity is gained. The participants evaluate the contents as adequate. The construction validity is gained because of the specific results of the questionnaire and the fact that it was possible to find correlations. The criteria validity could not be approved because there were no results of other surveys with which to compare. The results of the German company could not be directly compared because they are specified according to the automotive sector and accomplished with European companies. There are Austrian companies which participated in this study but Agamus Consult did not report these single results.

After the development of the questionnaire, an e-mail with the link to the survey was sent to the companies of the population. After 3 weeks the survey was closed. In total 513 e-mails were sent. While 90 mails where rejected because of invalid e-mail-addresses 110 companies responded validly. So the response rate amounted to 26%. As mentioned before, the results cannot be generalized to the entire population of Austrian industrial companies directly. An additional related restriction is that there was no randomness of the participating companies because of the limited availability of databases. Nevertheless, the received results are significant for the defined sample because of the relatively high response and therefore a tendency can be deduced.

3 Lean Production in Austrian Companies – The Results

This section discusses the general analysis of the results of the survey and is structured in four parts, namely, the structural data of the participating companies, the defined lean principles and methods as well as the degree of implementation, the acceptance of implementation and the structural/organizational integration.

3.1 Structural Data

Overall, 110 manufacturing industrial companies in Austria with more than nine employees participated in the study "Status Quo Lean Production in Austrian Companies."

The sectors with the highest participation were the machinery and metal goods industry and the electrical and electronics industry with a quotient of 37% and 17% (Fig. 2). These results reflect the structure of Austrian industry because these sectors have the largest proportion of the population in general.

More than half of the questionnaires were answered by small businesses with a number of 50 employees. With increasing number of employees the number of participants decreased. Only small percentages of companies that employ more than 150 people participated in the study. This is due to the fact that the majority of

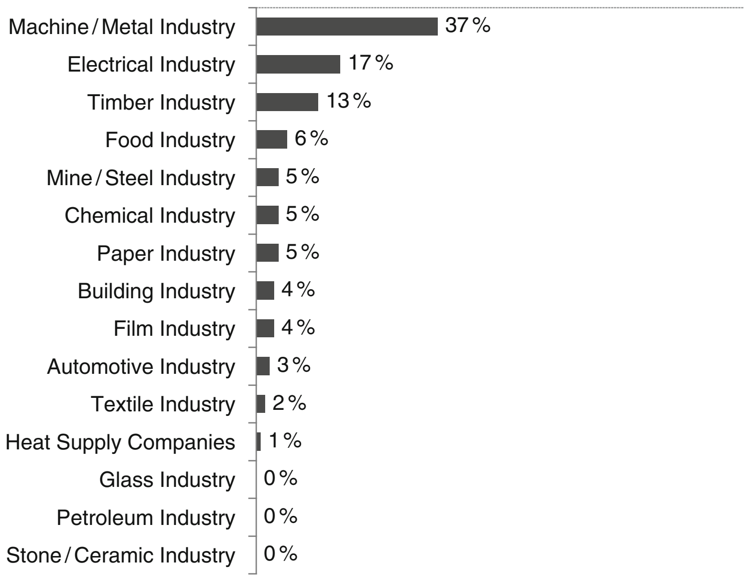

Fig. 2 Industrial sector

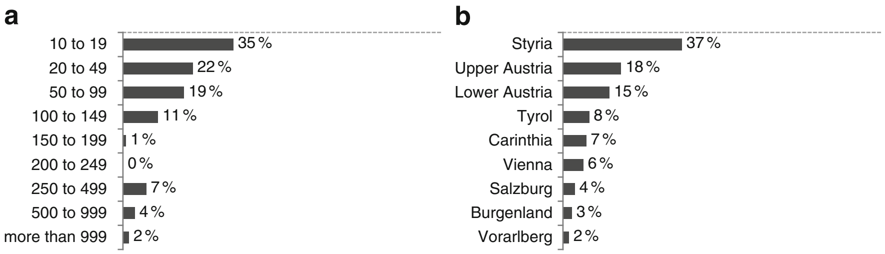

Fig. 3 Company size by number of employees (**a**), proportion of the states (**b**)

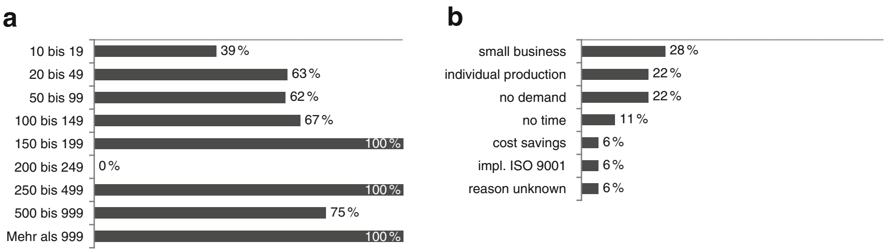

Fig. 4 Lean awareness by number of employees (**a**), reasons of no interest in lean (**b**)

Austrian enterprises are small and medium sized businesses. Furthermore, some companies with more than 250 employees declared that they have a lower interest in survey participations due to increasing number of requests (Fig. 3a).

Most responses were given by companies from Styria and Upper Austria which are the locations with the highest localization of industrial companies in Austria. The lowest proportion of 2% was recorded from Vorarlberg (Fig. 3b).

The survey was primarily directed to the production managers of the respective companies and 88% of the questionnaires were directly answered by the defined target group.

The most important criteria to determine the status quo is the knowledge and the awareness of Lean Production. Out of the 110 surveyed companies, 59% know this term, whereas, the remaining 41% did not know it.

The best conditions to implement Lean Production holistically and successfully are large companies that have the necessary financial resources and are specialized in the production of large quantities. There was a correlation between the number of employees and the recognition of LP found in the companies. The more people who are employed in a company, the higher the degree of awareness is. As Fig. 4a shows, only 39% of companies with 10–19 employees know the concept of Lean Production. However, more than half of the companies with 20–149 employees know that term and almost all surveyed companies with more than 150 employees are familiar with the concept. Only one company which employs 500–999 employees did not know Lean Production.

Only to those companies who were familiar with the concept of Lean Production were asked the question in which phase of lean implementation they currently the respective companies currently are. Among these, 28% responded that they have no interest in a lean implementation, 18% plan a future introduction and the remaining 53% already use Lean Production.

The most common argument of not implementing LP is the small size of business. Other reasons are individual production, lack of demand, no time, cost savings and current implementation of the quality management standard ISO 9001 (Fig. 4b).

3.2 Lean Principles and Methods and Degree of Implementation

The following analysis addresses the level of implementation of the various principles and methods as well as the degree of implementation in order to define the general status of lean implementation in Austrian industrial companies. The number of those companies which currently implement or have already implemented Lean Production is used as a basis for the subsequent statements.

Initially, the degree of implementation of the five principles including value, value stream, flow, pull and perfection were analyzed. All companies defined the value from the perspective of the customer. More than half of the companies strongly aligned their products and processes with the customer needs. Even 20% practice this principle very strongly. This basically applies to companies in the electrical and electronics, machinery and metal goods industry. Therefore, the enormous competition in the context of the ever-shortening product life cycles can be considered as a trigger. With the definition of the value from the perspective of the customer, customer satisfaction can be improved, which leads to an increasing customer loyalty and decreasing fluctuation.

Fourteen percent of the companies did not apply the principle "definition of the value stream." More than a third of the companies were strongly trying to identify the value stream and 14% even applied this principle very strictly to avoid non-value-adding activities. In general, all companies, no matter which branch they belong to and how many staff they employ, should try to identify the value stream to create lean processes and avoid waste.

The processing of goods in a continuous flow was related to 37% strongly and to 11% very strongly. This applies to the mechanical engineering and metal goods industry, automotive industry, mines and steel industry and chemical industry. These results can be attributed to the large number of manufactured pieces and similar product families of these companies which support the implementation of the principle "flow."

The pull principle was applied little to not at all. This applies mainly to the sectors of timber and paper industry. This may be due to the fact that these companies generally produce their products before receiving actual customer orders. They generate their production plan based on their market knowledge and experience. Customization will be made at the last workstation.

The principle "striving for perfection" was strongly used by more than two-thirds of the surveyed companies. There is no assumption of a certain business size or production structure to act in accordance with this principle. Every company can and should act on "perfection" because it ensures that existing processes are continually challenged and changed to positive.

With regard to the precise knowledge of the current implementation level, the average of each principle was calculated in order to make a comparison for the implementation level (Fig. 5a). The horizontal axis describes the degree of implementation and should be interpreted as follows:

Not implemented	0
Little implemented	1
Half implemented	2
Strongly implemented	3
Very strongly implemented	4

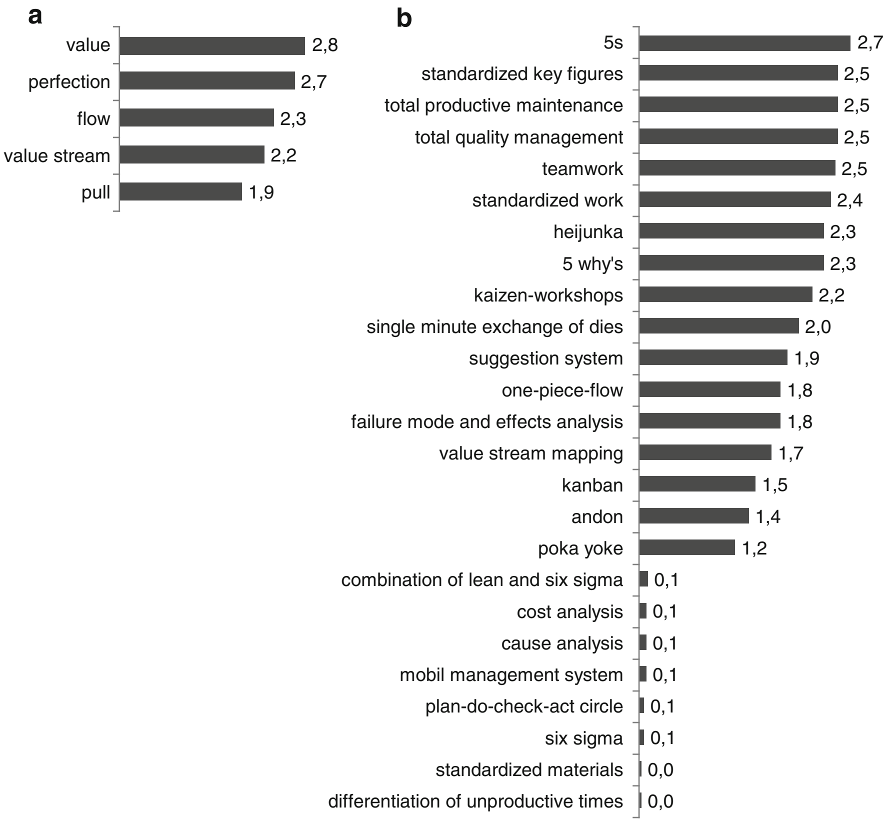

Fig. 5 Average degree of implementation of lean principles (**a**), average degree of implementation of lean methods (**b**)

It is shown that the average degree of implementation of the principles range from "little" to "strongly" implemented. This means that the principles are although implemented in the companies, but there is still a need for action to intensify the implementation level of the principles.

The principles "define the value from the perspective of the customer" and "strive for perfection" are furthest established in the companies because none of these depend on a specific industry or a manufactured quantity which is also applicable to the "identification of value stream." The "flow" principle and the principle "identify the value stream" are used on average by half. The "pull principle" is used little in Austrian companies. This is due to the fact that this principle depends very strongly on the specific industry with standardized and harmonized production processes with a high number of produced units.

Figure 5b shows the analyzed methods, based on the defined methods of the author comparison which were shown in Fig. 1 and compared to their average degree of implementation. The extent to which the different methods are introduced, is shown on the horizontal axis which should be interpreted as follows:

Not implemented	0
Pilot phase	1
Half implemented	2
Largely implemented	3
Fully implemented	4

The average degree of implementation of the lean methods ranges from "pilot phase" to "largely implemented." It can be concluded that some companies have already been very busy with the introduction of methods, but there is still a considerable potential to intensify these in their application.

The method of the "5S" is implemented with the most intensity of all the analyzed methods. It is the only one that was, on the average, largely implemented in the companies. This can be attributed to the fact that this method can be applied inexpensively and in any company. Methods with least degree of implementation are: "Kanban," "Andon," "Poka Yoke," and the others like the "combination of LP and SixSigma," "cost analysis," "Mobile Management System," "Plan-Do-Check-Act Circle," "SixSigma," "standardized materials" and the "differentiation of unproductive times." The result that the implementation level of "Kanban" is on average very low can be associated with the low implementation level of the pull principle. The method "Andon" is very cost-intensive and "Poka Yoke" has the serial production as a precondition. For companies that produce low batch sizes because of customer's individual demand this methods are not applicable.

The analysis of the principles and methods shows that the attended companies have already kept busy with Lean Production, but it also shows that there is a lot of potential for improvement concerning the implementation level of Lean Production. The general status is that principles and methods, which can be implemented in any company no matter which form of production is applied, have the highest level of implementation.

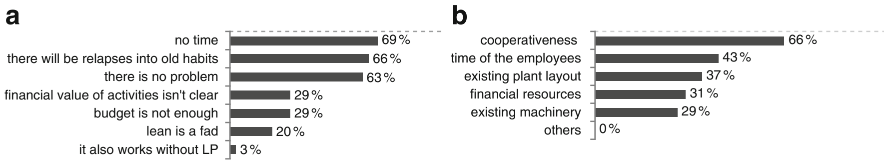

Fig. 6 Most mentioned arguments against lean (**a**), most common problems during implementation (**b**)

The next step addresses the acceptance of Lean Production in companies concerning the employees, as well as the managerial acceptance.

3.3 Acceptance of Implementation

The biggest resistance to lean implementation was observed in the foremen in 54% of the surveyed companies followed by the employees on the shop-floor level with 43%. In only 3% did the middle management resist the implementation of Lean Production. In all companies the top management is seen as a role model and has completely internalized the lean culture.

The most common arguments against a lean implementation were as follows: "no time," "there will anyway be relapses into old habits" and "there is no problem." Other arguments such as "it has also worked without Lean Production the last 20 years" and "lean is a fad" were the least mentioned arguments against lean (Fig. 6a).

The most commonly cited limiting factor during the implementation is the lack of willingness of the employees to deal with the lean philosophy. This may be due to the fact that many companies underestimate the importance to involve employees in the lean implementation. The willingness of the employees has increased in businesses, which employ a lean manager. It can be derived that it is important to establish not only the methods but also the familiarity of the people with the situation and to train them accordingly (Fig. 6b).

The acceptance of the LP implementation is essential to the success of this concept. The survey showed that the largest resistance comes from the foremen. This can be attributed to the fact that very few targets have been defined with this group. So it is very important to have lean target agreements and convince the employees of this concept to raise acceptance of LP.

The next section discusses the organizational integration of Lean Production with reference to the implementation period and the need for further action.

3.4 Organizational Integration

The majority of companies (63%) implemented lean principles and methods for less than tree years. In 26% of the cases the companies were already in the implementation phase for 3–6 years and 11% were adopting Lean Production for more than 6 years (Fig. 7a).

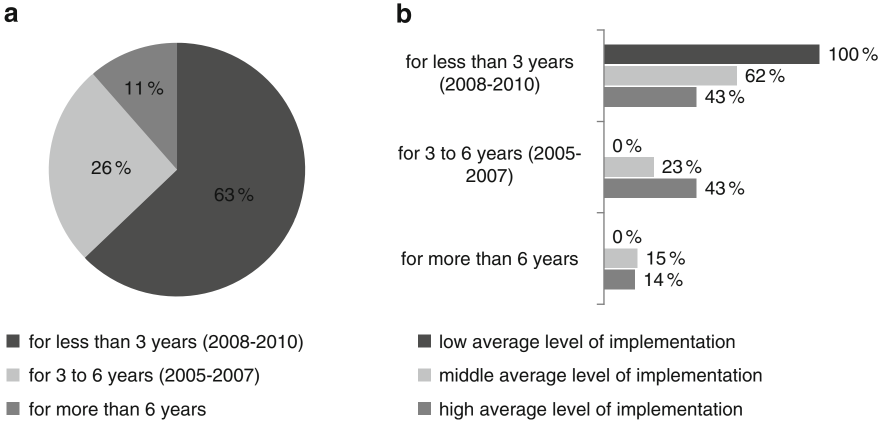

Fig. 7 Adoption period lean principles and methods (**a**), connection between the average level of implementation and adoption period (**b**)

There was a connection established which states a low degree of implementation of Lean Production, due to the fact that the respective principles and methods have been implemented since 2008. All businesses with a low average level and most of those with a medium level of implementation adopted lean principles and methods for less than 3 years. According to analysis of the results, this noted difference between low and medium level of implementation is influenced by the intensity of implementation. More than half of the companies with a high average implementation level adopted the principles and methods for more and 43% for less than 3 years (Fig. 7b). One important fact which includes future implication is that 89% of the surveyed companies plan to intensify and improve the recent lean approaches. Only 11% are satisfied with the current implementation status and do not plan any further implementation activities. Additionally, 40% of the companies are satisfied with the speed of implementation. The remaining 60% stated that the implementation is carried out too slowly.

When asking whether there are LP related objectives declared within the levels of top management, middle management and foremen, the choice of multiple answers was possible. In 20% of the companies, there were no target agreements, which occurred mainly in firms with a low average degree of implementation. Concerning the other ones, target aggreements existed in 49% of the top management, in 57% of the middle management and 40% of the foremen (Fig. 8a). Furthermore, 57% of the companies confirmed a realistic planning of resources. Additionally a correlation between the reporting and the capability planning was found. The majority of companies stated that they can present a realistic planning because of their reporting system.

When asked to what extent they agree that the lean ideas play an important role in the companies, then with an expectation that the businesses with an advanced lean culture would have an advanced level of implementation.

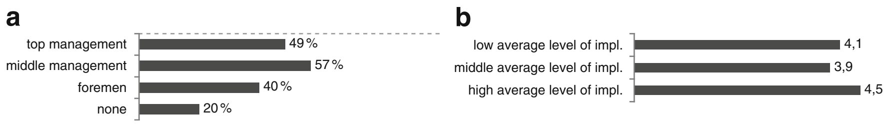

Fig. 8 Target agreements (**a**), importance of the lean concept dependent on the level of implementation (**b**)

Figure 8b shows the extent to which this assumption is true. The data label should be interpreted as follows:

Strongly disagree	1
Rather disagree	2
Agree in part	3
Agree to a large extend	4
Strongly agree	5

The involvement of the employees is an important factor for the success of Lean Production because they have to apply the principles and methods accordingly and internalize the lean culture. In order to achieve this acceptance it is necessary to ensure that employees become involved in different lean activities. Figure 9a shows that employees can participate in 86% of the companies through workshops. In 66% of the surveyed companies workers would be asked to contribute suggestions for improvement and in 43% the employees would be included in projects. Training and appraisal interviews were used in 6% of the companies in order to involve the employees in lean topics. In addition, it was deduced that the suggestion system was primarily applied in companies with a high average level of implementation of Lean Production. Thereby 70% of the suggestions were rewarded which led to an increased number of proposals.

The following questions elaborate on how the companies deal with lean success. To determine the degree of managerial attention regarding the lean success, the respondents chose from a scale from “no attention” to “very much attention.” It turned out that the attention of management concerning the lean success differed from “adequate” to “much attention” most frequently (Fig. 9b).

Figure 10a shows that the management of companies with a high average level of implementation devoted far more attention to lean success than companies with a lower average level of implementation. This result shows that the majority of managers were familiar with their function as a “role model” in terms of LP.

In 57% of the companies, employees who had contributes to the success with LP received further education or training. In 51% of the firms, employees are rewarded monetarily. Furthermore, employees had the chance for promotions or more challenging activities in 43% of the companies. Acknowledgement for contribution was given to employees in 20% of the companies (Fig. 10b).

The analysis of the organizational integration shows that the most companies implement lean principles and methods for less than 3 years and 80% of all those surveyed have target agreements with different hierarchical levels. On average, the

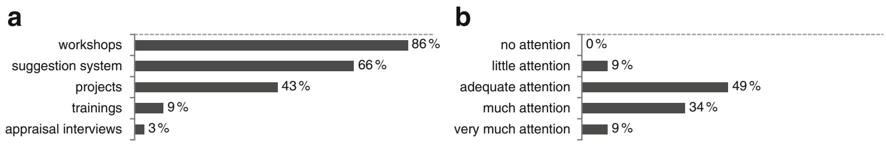

Fig. 9 Involvement of the employees (**a**), degree of management attention regarding the lean success (**b**)

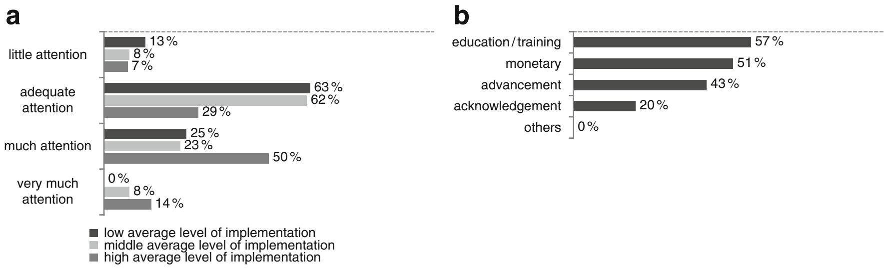

Fig. 10 Degree of management attention as a function of the implementation level (**a**), applied considerations of employees contributed to lean success (**b**)

lean concept has a very important role in all companies. This can be attributed to the fact that the employees became involved in lean subjects with different methods like workshops or education. Another very important role concerning the organizational integration is the degree of managerial attention regarding lean success which is provided in most cases. If lean success is recorded, the majority of employees are recognised with further education and training or monetary rewards.

4 Conclusion and Managerial Insights

In general, the most commonly used principle of LP is the definition of the "value out of the customers' perspective." In contrast, the least common one is the "pull-principle." Therefore, the method of "Kanban," as a demand-driven "pull-system," is rarely applied within the surveyed companies. Other methods like "5S", "standardized performance metrics" or "TPM/TQM" are applied frequently. These results may reflect the structure of the Austrian industry with a very high amount of small and medium sized enterprises (SMEs). According to the statistic institution of Austria, approximately 99% of all industrial companies were SMEs in 2008. Among these 77% employed less than ten employees (Statistik 2008). While, for example, "5S" or "standardized performance metrics" could be implemented without a huge amount of resources (e.g. time, money), other methods like "Kanban" are more complex. Additionally, these small companies normally tend to have low batch sizes according to the variety of customers' individual demands. The approach of Lean Production, especially the pull-principle in the peculiarity of Kanban, needs a certain amount of parts otherwise the effort of implementing value streams is not worth it. If the batch size is low and the number of customers' individual demand is high, processes have to be agile rather than standardized (Womack et al. 1990; Christopher 2005). In this context Bohan (2010) added the hypotheses, that especially SMEs could use more lean tools for creating more agility by reducing manufacturing cycle time, inventory levels and increase customer service. Concerning the degree of implementation it can be concluded that some companies have already been very busy with the introduction of methods, although there is still a considerable potential to intensify these in their application.

To ensure an efficient implementation and to avoid problems a priori, the management has to face the fact that the biggest resistance to lean implementation is seen in the foremen and followed by the shop-floor employees. Due to these results, the importance of employee information and, of course, integration in the development and implementation process is very important. Furthermore, the top management has to take responsibility and act like a role model concerning the lean culture.

The most common arguments against a lean implementation are "no time," "there will anyway be relapses into old habits" and "there is no problem." Other less common arguments are the budget situation and doubts of the financial value of lean. As the stated arguments show, informing the employees and especially the awareness for the need and the opportunities of LP are important success factors for an efficient and effective implementation. In summary, the most commonly cited limiting factor during the implementation phase is the willingness of the employees to deal with the lean philosophy and not, for example, the principles and methods themselves. Due to these results, the new hypotheses can be deduced that many companies underestimate the importance to involve employees in the lean implementation or they have no structured approach in doing so.

Concerning the organizational integration, it can be stated that companies which have further implemented LP, tend to focus not only on lean methods but also on lean culture which correlates with previous statements. Additionally, these companies devote far more attention to lean success than companies with a lower average level of implementation. In 80% of the surveyed companies target aggreements are defined especially at the middle and top management but also with the foremen.

According to the survey, the most common ways for employees to participate in lean activites are workshops, suggestion systems and projects. Therefore, it is interesting that a suggestion system is primarily applied in companies with a high average level of lean implementation. If success out of lean initiatives have been recorded, the employees who had contributed received the possibility to participate in further education or training, were honoured monetarely or received advancements.

The premise of Faust (2009) that a second lean-hype is raising was also have been reflected by this investigation. Nearly two thirds of the surveyed companies are implementing and applying Lean Production since 2008.

In the introduction the hypothesis of Singh et al. (2009) was introduced. Specially, the recession has contributed to the lean hype. While the authors tend to agree to the hypothesis it cannot be validated by this survey.

Finally, it can be said that LP will be continuously important for the future. This hypothesis is deduced from the fact that almost 90% of the companies which know or respectively are concerned with LP confirm additional need of actions and improvement for the next few years. Therefore, the requirement of further development, implementation and application of lean approaches as well as the integration of the employees in the process of change can be predicted. According to the Austrian industry, which consists mainly of SMEs, it would be interesting to elaborate on the question how to adapt the lean approaches and methods to the individual situations and demands in order to achieve more agile processes. Additionally, there is still a gap of knowledge and awareness which has to be closed. This is based on the fact that 41% of the surveyed companies did not know the term LP at all.

However, to answer these questions additional research in the field of Lean Production is required in order to meet the future demands of the Austrian industry. Therefore, further studies of barriers in the organization and approaches of overcoming resistance offered to LP can be suggested. Furthermore, the opportunity to apply lean methods and principles for the purpose to improve agility concerning customers' requirements especially in SMEs should be explored.

Acknowledgments The authors gratefully acknowledge the company Agamus Consult for the friendly permission to use their questionnaire as basis for the survey. Furthermore, the authors would like to express their gratitude to Dr. Laura Baker and Ms. Sandra Streit who contributed with their expertise.

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Lean, a Tool Set or a Mind Set? A Healthcare Case Study

Cristina Machado Guimarães and José Crespo de Carvalho

Abstract Applying "Lean" (Womack and Jones 1996 [2003]; Hines et al. 2004) in healthcare services has been the most visible and recent trend in services industry (Brandao de Souza 2009; Holm and Ahlström 2010; Jones 2006). However, is "Lean" in healthcare just a buzzword, a set of tools (Hines and Rich 1997) for quick-wins or a sustainable enterprise process improvement system? Lean thinking has a sustainability issue that needs to be addressed. In order to assess how embedded are Lean principles and tools in healthcare and how organizations sustain the gains, a case study was conducted in a healthcare organization with 21 diagnosis units running *Kaizen* events. This study aims to bring some answers regarding the regression causes in Lean practices and healthcare organizations priorities in matching customer needs to value streams provided. Conclusions about: (1) translation of Lean models and practices from other settings (manufacturing) to healthcare (services), (2) how elimination of waste in healthcare is made by eliminating non-value-added activities and how customers perceived the value creation, and (3) how is (internal and external) communication of value, are presented, as well as some thoughts concerning the future of Lean in healthcare. In spite of being supported by a single case study, the followed approach and the research design enables any other researcher to replicate it in other units of analysis with similar inclusion criteria.

Keywords Kaizen • Lean thinking • Sustainability • Value chain • Value communication

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_16,

1 Introduction

Healthcare services waited 60 years for manufacturing lessons and rush in to implement these improvement principles and tools. However, there are contextual variables of Lean adoptions in services, such as “value” and context specificities in healthcare services (Dal Pont 2010; Young and McClean 2008, 2009). In fact, pursuing value creation is one of the challenges in assessing Lean application outcomes in healthcare.

Radnor and Walley (2008) found the following barriers in Lean principles and tools implementation in public services (including healthcare services): lack of clear customer focus, too many procedures, people working in silos, too many targets, lack of awareness of strategic direction, general belief that staff are overworked and underpaid, and finally, lack of understanding of the effect of variation, systems thinking and process flow. Silva et al. (2010) used survey to explore Lean production through non-Lean implementer’s perceptions regarding the implementation barriers as well as the drivers and achievements of implementation. Browning and Heath (2009) explore Lean implementation complexity and difficulties through a case study in aircraft manufacturing. Other authors (Radnor and Walley 2006; Hines and Lethbridge 2008; Scorsone 2008; McQuade 2008 among others) show that different corporate cultures – particularly those in public sector – can inhibit the application of Lean techniques. Thus, we arrive to our first Research Question: **RQ1 – What are the barriers to Lean implementation in healthcare?**

On the other hand, Achanga et al. (2006) outlined the importance of leadership, management, finance organizational culture and skills, as well as expertise, among other factors, as critical success factors for implementing Lean in manufacturing settings. But what are Lean implementation critical factors in healthcare setting? That’s our second question: **RQ2 – What enables Lean implementation in healthcare?**

Is “Lean” a goal or a journey? According to Goodman et al. (2007) the Lean project termination is just the beginning. Some Lean initiatives seam to present a prescriptive tone by testing some of those tools in pilot projects (Grunden 2009), combined tools (Buesa 2009), seeking for rapid improvement (Wennecke 2008; Caldwell 2006). The difficulty is to sustain Lean practices and prevent turning to previous comfort zone (Lucey et al. 2005). As supported by several authors (Hines 2010; Radnor and Walley 2008; Radnor and Holweg 2010; Womack 2007, among others). Lean thinking sustainability is an issue that requires more empirical research. The importance of a Lean sustainable culture enhances long-term benefits focusing. The focus has changes from “how to go Lean” to “how to stay Lean” (Hines 2010) which leads to the last, but not least, question: **RQ3 – How to develop a sustainable Lean culture?**

In order to assess how embedded are Lean principles and tools in healthcare and how organizations sustain the gains, a case study (Yin 2009) was conducted in a healthcare organization with 21 diagnosis units running *Kaizen* events.

This study aims to bring some answers regarding the sustainability of Lean practices in healthcare organizations. Conclusions about: (1) translation of Lean models and practices from other settings (manufacturing) to healthcare (services), (2) how elimination of waste in healthcare is made by eliminating non-value-added activities and how customers perceived the value creation, and (3) how is (internal and external) communication of value, are presented, as well as some thoughts concerning the future of Lean in healthcare.

Presenting a contribute to empirical studying of Lean deployment in services settings, this article first briefly reviews the literature on Lean services, enhancing the Lean "translation" and evolution from manufacturing to pure services settings, giving special relevance to healthcare services. Also revision on tools and long *versus* short-term events is presented with strong emphasis to critical success factors and "people" issues as roots of sustainability of Lean. The retrospective case is reported as a search for evidence to answer the previously presented questions.

2 Lean Services

2.1 From Manufacturing to Services

Presented as an antidote to *muda* (waste), converting *muda* into value, "Lean thinking" was coined by Womack et al. (1990) as a five principle improvement philosophy: (1) specify value, (2) identify the value stream, (3) make the value-creating steps for specific products flow continuously, (4) let the customers pull value from the enterprise, and (5) pursue perfection. These same principles prevailed though the Lean concept scope evolution (Fig. 1).

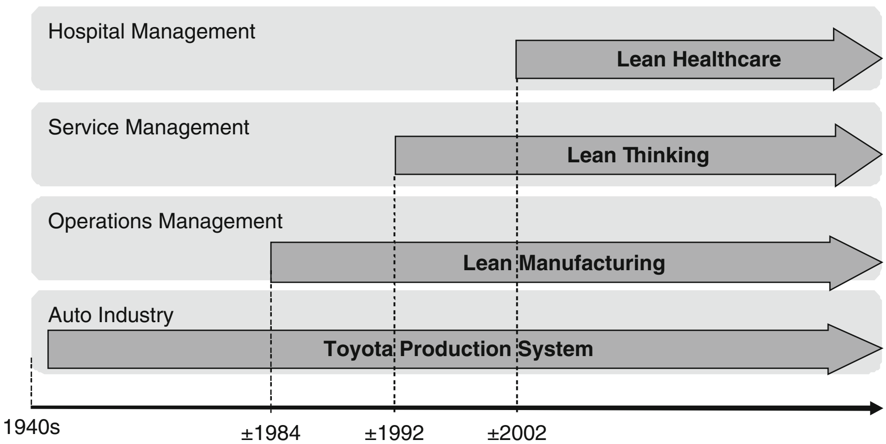


Fig. 1 Lean concept scope evolution (Source: Adapted from Brandao de Souza (2009))

The roots of application of Lean manufacturing principles (personnel's limited discretionary action, division of labour, substitution of technology for people, standardization) to service settings can be found in the work of Levitt (1972, 1976). We've been assisting throughout the decades to successful attempts of "industrializing" services to solve mass-production approach limitations by adopting and adapting "Lean" principles (Hines and Rich 1997; Bowen and Youngdahl 1998; Allway and Corbett 2002; Ahlström 2004; Piercy and Rich 2009a, b).

However, some Lean applications to services are claimed to be "Lean service" but are just applications of Lean production to material processing tasks in service companies. On the other hand, pursuing Lean principles as standardization might seem paradoxical in services settings due to variability introduced in operations by customers (Kosuge et al. 2010). In a complete literature review, Holm and Ahlström (2010), through a categorization of current Lean service research, identify different levels of Lean deployment in services that goes from a simple tools/technique/method-focus, then to single principle and, broadly, to multiple principles focused studies. This review, using the Silvestro et al. (1992) classification of services (professional services, service shop and mass service), shows a main research incidence in "professional services", namely in Healthcare.

2.2 Lean in Healthcare Services

The adoption of Lean practices in healthcare has been studied and reported as success stories of strategic changes in healthcare organizations, as the Bolton Improving Care System – BICS (Fillingham 2007) and the legendary Virginia Mason Medical Centre Cases (Black and Miller 2008, 149–189). In 2003 revision, Womack and Jones (1996 [2003], 289) introduced the application of Lean thinking in the medical system. Some authors (Fillingham 2007; Kollberg et al. 2007; Lodge and Bamford 2008; Manos et al. 2006) advocate Lean practices to eliminate delays, waiting times, reduce length of stay, repeated encounters, errors and inappropriate procedures.

On the other hand, being the focus on "value" the critical point in Lean thinking, value creation in healthcare, a world "full of values" (Young and McClean 2009) depending on the many different customer groups (patient, patient's family, society, medical students – internal customers), has to be seen beyond cost reduction. Young and McClean (2008) conclude that there is scope for methodological development by defining three themes associated with value-the operational, the clinical and the experiential. In fact, pursuing value creation is, along with evidence and metrics, one of the challenges in assessing Lean application outcomes in healthcare.

According to Eaton and Phillips (2008) the success factors for edifying the Lean building are: (1) communications; (2) resources; (3) involvement; (4) training; (5) implementation/measurement systems; (6) compass; (7) achievement; and

(8) leadership. The authors value also the reward spirit and the expertise of external support that is useful to "look outside the box".

Also referring to success factors other authors (Achanga et al. 2006; Hines et al. 2008, among others) point the following Lean deployment enablers:

- Senior management commitment and engagement in improvement;
- Leadership at the top and at every level;
- Linking improvement to organisational direction;
- Time to allow impact to occur;
- Good customer understanding and response;
- Good understanding of the whole process;
- Training and development;
- Proper measurement of current performance;
- Engagement of all of staff.

The barriers can be seen as the opposite of success factors; however some barriers are common places of specific sectors. Studying cross-countries non-lean implementers, Silva et al. (2010) found as barriers to lean implementation: existence of other substitute initiatives, lack of communication, inability to quantify the benefits, lack of understanding of Lean principles, lack of senior management commitment, attitude of shop floor staff and multiple business location.

In Healthcare sector we can find public sector barriers such as: (1) resistance from staff with a strong powerbase, (2) the inability to define quality, (3) political pressures and changes in policy and (4) the perception that improvement techniques developed in manufacturing and are not appropriate in a service environment (Radnor and Walley 2008). In fact some authors (Radnor and Walley 2008; Hines and Lethbridge 2008; McQuade 2008; Scorsone 2008) point that different corporate cultures (particularly in public sector) can inhibit Lean implementation.

Dal Pont (2010), analysing Lean adoption techniques in services, define "enablers" of Lean deployment variables as: (1) process or/and service divisibility, serenity, (2) loyalty and leadership and (3) information technology (IT) skills. Conversely, define as inhibitors: (1) knowledge, (2) customer contact, (3) corporate culture, (4) complexity and (5) autonomy. Each of these variables' findings requires in-depth studying and testing, namely in healthcare setting.

3 Lean Tools, Quick-Wins and Long Term Behaviour

The root of Lean is the Toyota Production System (TPS). However many Lean subscribers ignore the system aspect rushing into tools and techniques *tout court*. The Lean healthcare reported cases are full of tool deployments. The Virginia Mason Medical Centre emblematic case describes Rapid Process Improvements Workshops (RPIW) to run Rapid Improvement Events (RIEs), 5S, Value-Stream Mapping (VSM) and *Kanban* (Weber 2006). Reporting Virginia Mason's case Spear (2004) describes RIEs results as "dramatic improvements in quality, customer satisfaction, staff satisfaction and profitability". On the other hand, the issue of only focusing on RIEs in isolation is highlighted by Radnor and Walley (2008) adverting to the difficulty in sustaining RIE's quick wins that are not integrated in the overall strategic objectives of the organization. However, when they are part of the strategy improvement programme, RIEs themselves can be a powerful mean to both engage and motivate the workforce and allow a number of small changes to occur producing a sort of a butterfly effect. Organisations often run a series of RIEs and see this as "Lean" or "process improvement" whereas in reality it is just *Kaizen* (continuous improvement). RIE is an important tool of Lean (Radnor and Walley 2008). According to Barraza et al. (2009) in continuous improvement (*kaizen*) events the length of implementation varies according to the extension of activities. The *kaikaku* or *kairyo*, for instance, are short-term (1 or 2 weeks) events in focused area that can work as *Kaizen* blitz, "bombing" workshops in the *gemba* (shop-floor). Having longer (based on traditional Japanese Quality Management system) or shorter dimension, the continuous improvement events are part of a journey to a Lean enterprise as Lean-*kaizen* events (Manos 2007).

As Spear (2004) reports on Toyota "People don't typically go for big, dramatic cure-alls. Instead, they break big problems into smaller, tractable pieces and generate a steady rush of iterative changes that collectively deliver spectacular results." However, as Hines et al. (2008) report, one step at a time approach can be taken in order to deliver quick wins but "once the message has got across you need to progress to more ambitious, long term projects." The authors highlight the importance of tools as visual management and regular process auditing (Hines et al. 2008).

In the case study analysis of 5S projects in healthcare Esain et al. (2008) noted both emergent and planned change approached. They also noted a paradox in that "change agents seem to unwittingly want to make the process neat by adopting the prevalent command-and-control organisational model of management which may restrain spontaneous change and learning. This could be resolved by ensuring that enthusiast converters and others judge the activity that they are proposing aligns with the vital few objectives of the organisation, but this assumes a clear strategic organisational vision." In fact, sustainability failures proved that the whole is not the sum of the parts, most of the time. Jackson (2009) describes the five pillars of 5Ss implementation in healthcare "facilities" leaving the prescription of a good workplace as scenery of future continuous improvement actions.

Hines (2010), among others, posits that the pure and simple tool deployment to achieve quick-wins lead to a short term Lean results and often returns to "the comfort zone" whilst systematic Lean approaches of culture changes shows long-term results, even in the same corporation (ex. Whirlpool). Using the iceberg metaphor the author shows that sustainability doesn't come from working only the visible part of the iceberg (technology, tools and techniques and process management) but mostly work below waterline with much bigger and real sustainability keys as: (1) strategy and alignment; (2) leadership; and (3) behavior and engagement.

Forrester (1995) links the sustainability of Lean deployment to the human elements and advises to consider elements as: (1) organisational style and structure (a people centred process, with involved, motivated and accountable teams and leader empowerment, flat structure focused on processes not hierarchies); (2) staff selection (based on management and leadership skills, give clear and individual performance targets); (3) training (solving problems and other individual continuous development programs). Also Womack and Jones (1996) point out the importance of one of first four Lean principles "all interact with one another in a virtuous circle" as the goal is not playing individual notes but a tune.

Some authors (Lucey et al. 2005; Manos 2007; Proudlove et al. 2008) suggest that medium/long term achievements in Lean and six sigma implementations are due to: standardization training, measuring employers engagement with the company and with the customer, monitoring results, management commitment and ownership to maintain and improve gains and also learn from external support how to develop internal mechanisms for sustain improvement.

Bateman and Rich (2003) refer to sustainability by relying on success factors or organisational readiness what can be reductionist if differences in public versus private organizations success factors were ignored. Time and readiness are issues that belong to an organization DNA. Toyota took 20 years to develop its system. Bale and Regnier (2007) report a Lean experience in healthcare setting that took 3 years to achieve stability. Hines et al. (2008) suggest that generally Lean systems take between 3 and 5 years to develop and between 5 and 7 years to implement. Distinguishing "performance improvement" from "continuous improvement", Bateman (2005) state that performance improvements occur after a few months and have a supporting role to continuous improvement.

Hines et al. (2008) suggest that what makes "Lean stick" is leadership. Hines (2010) recent article explores Lean sustainability in multi-site organizations stressing behavior and engagement importance and defending "*Hoshin Kanri*" or policy deployment as a strategy alignment weapon, but not in a pure service setting.

Most of the literature on Lean services does not cover "people aspects" and behavior in organizations questions even though they are crucial to Lean implementation success. As Spear (2004) concludes "in health care no organisation has fully institutionalised to Toyota's level the ability to design work as experiments, improve work through experiments, share the resulting knowledge through collaborative experimentation, and develop people as experimentalists."

4 Methodology

According to Yin (2009), case study method is appropriate to "How" and "Why" questions and to investigate a contemporary phenomenon in its real-life context when the boundaries between phenomenon and context are not evident recurring to several data collection techniques and different evidence sources. This qualitative method, allowing a deeper understanding of phenomena (Flyvbjerg 2006), has been frequently used in management studies, namely in operational management (Voss et al. 2002) and logistics (Ellram 1996; Renner and Palmer 1999). Case studies are also used for building theory (Eisenhardt 1989).

Being more an idiosyncratic than a generalizing method, was chosen by its descriptive and exploratory character, not to produce causality statements but to achieve a logical sequence of connection between empirical data, problem/research questions and findings/conclusions. Though, the unit of analysis was chosen according to the research objective: to study sustainability factors in Lean deployment. Hence the attention was given to each single Lean implementation project, elected as the study's unit of analysis. Each project, by definition, has its own patterns and ways that allow contributions of different findings. The *kaizen* projects – units – were selected to allow replication (Yin 2009) increasing the external validity of findings.

As recommended by Yin (2009) in data collection and analysis, a study protocol was followed. Multiple sources data triangulation was given special attention during data collection (Eisenhardt 1989). For data collection (from July to October 2010) we've conducted ten in-depth semi-structured interviews to different functional areas actors in *kaizen* events (to the CEO, COO, the external consultant, the business area director, two department managers, three front-office elements and the quality manager), recurred to document analysis (company profile, workshop presentations, internal memos, structural charts, written procedures, quality manuals) and direct, non-participant observation (*gemba* "to be" state) (Saunders et al. 2007). Interviews had an average duration of 2 h and were tape recorded and fully transcribed. Data analysis followed Miles and Huberman (1994) recommendations on data codification, reduction and categorization techniques. Data gathered from different informants and sources was reduced to precise categories in common tables (Miles and Huberman 1994), and then systematically interrogated (Yin 2009) comparing and noting patterns (Miles and Huberman 1994).

The results were compared with an on-going review of the literature to support findings or bring new directions to explore.

5 Case-Study in a Diagnosis Group of Clinics

ES (acronym for privacy reasons) is a group of 21 clinics providing diagnosis exams and therapy in areas as radiology, cardiology, nuclear medicine, laboratory and physiotherapy in an extended geographic area covering all north part of the country.

A new administration board started functions in 2008, at that time with 15 units, and followed a growing strategy by acquisition. A big effort has been made ever since, to achieve homogenization of procedures and create a corporate image. Some help from previously initiated quality certification was taken into a broader extension and most of the units now follow ISO quality norms. Radiology was the first area to be certificate by ISO 9001. Another contribution to homogenization came from constant training plans to all staff in different themes (reception, customer service, time management). The standardization of processes among so "many different ways of working" was a challenge to an organization that was giving its first steps in healthcare sector. Searching for efficiency gains and copping with geographic dispersion, practices as telemedicine (in radiology and cardiology) were encouraged.

Motivated by the known results of *kaizen* events in manufacturing, and in some services, the choice of contracting consulting services with *kaizen* events experience was seen by the interviewees as a the driving force with the ability of "looking outside the box" and presenting a "success guarantee". The plan was to run a *kaizen* project in the biggest unit of radiology (out of nine units, half of total), to form multi-professional groups, including two members of the other 19 units, creating a "spreading agent" to replicate the same improvement process in the rest of group units.

The intervention model proposed was to run workshops of 5S concerning back-office area, radiology rooms, front-office and warehouse.

The *kaizen* project was designed for 10 month duration (assessment, training and implementation) starting in February of 2009.

Starting with Value Stream Mapping (VSM), the customer path designed and activities analysis showed a current sate lead-time of 4–5 days and a future state stream was designed to achieve an average lead-time of 30 min. This goal would be possible to achieve through paper elimination and setting a new flow of information and customers.

In the assessment phase, after VSM a 5S current and future state was presented, scoring the existing levers of: sorting (*seiri*); simplifying (*seiton*); sweeping (*seiso*); standardizing (*seiketsu*) and self-discipline (*shitsuke*), showing the gap and size of journey to follow as the example of the report room assessment presented in Fig. 1. The initial audit was carried out in file rooms, reception, report room, radiology rooms, waiting areas and warehouse.

After some spaghetti diagrams new lay-outs were design in order to gain space and allowing 5S deployment, as in Fig. 2 example.

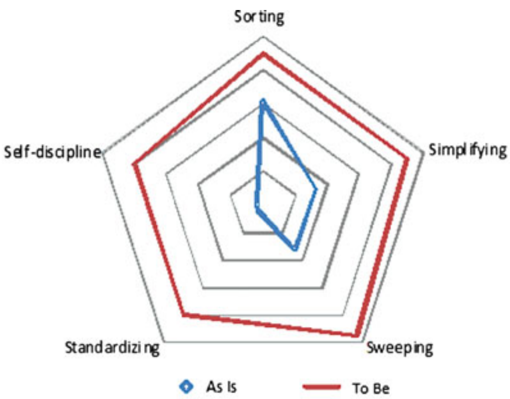
The project implementation was carried out by steps (Table 1), each one with duration of a week and devoted to a specific workshop theme with correspondent *gemba*-homework tasks to be evaluated in the beginning in the following session. Rewards were encouraged.

All interviewees enhanced the fact that there was a clear vision of the improvement results benefits and it would never have reducing staff as consequence. Redundant work was to be eliminated but not people. Staff reallocation was predicted and communicated in workshop sessions.

There was also a common felling among the kaizen actors, that a lot more could be done, but the "a healthcare unit can't stop" and involving all personnel would take longer. One manager claims that workshops were designed without some valuable inputs of daily problems and that would make a difference in having a broader scope.

The *kaizen* project intervention areas improvements are presented in Table 2.

When asked for future improvement actions, two unanimous ideas are in the interviewees minds: – the poor impact that this "beginning" had in customer



Date	Sorting	Simplifying	Sweeping	Standardizing	Self-discipline	Total (%)
05-03-2009	63	33	33	4	3	36
Objective	90	90	95	80	80	87

Fig. 2 5S goals of report room

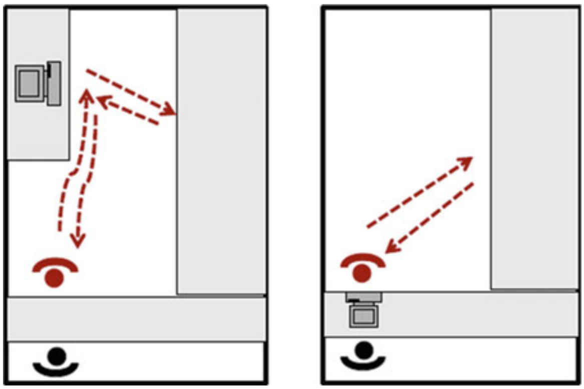


Fig. 3 Current and future file room lay-out

perception of improvements and the difficulty of measuring results of this actions in the long-term for lacking of monitoring.

Consultants left at the end of the project and since February of 2010 the organization has made few attempts to replicate the first unit kaizen project recurring to the "improvement agents" trained in *kaizen* workshops sessions, apparently with no results apart from "cleanness".

Table 1 Steps of Kaizen project

Step	Description
1. Presentation of the project	The top management introduces the issue of improvement. The consultant presents to a wide group of participants the purpose, focus and coordination of kaizen project
2. Before initiating training	Presentation of the project plan and time table. Team selection
3. 5S Kaizen workshops in selected areas	Each workshop had 1 day duration (training in first session – audit and training in the followings)
4. Result presentation and guided visit	Meeting with all first meeting participants and *gemba* visiting

Table 2 Project improvements per process

Process	AS IS	TO BE
Reception	Unnecessary furniture	Clean look
	Interruptions to find material	Material individual kit, standardized forms
	Unorganized waiting area	New "U" lay-out of waiting areas; wider circulation area suitable for disable
	Confusion in queue selection	Centralized call system
Report writing	Difficulty of finding exams	Visual management deployment
Filing	Different criteria of filing	Criteria and filing material standardized
	Maintenance of all dates "dead" file	Elimination of post-dated "dead" file
Stock management	"Empirical" stock management	*Kanban* system
	Validity dates not controlled	Daily fulfilment with standard routes
	Frequent stock-out	Warehouse organised by fixed positions
	Intra and inter-unit loans	Reduced stock level
Radiology rooms scheduling	Difficulties of planning	Visual management deployment
	Inefficient professionals scheduling	
Patient transport (local hospital outsourcer)	Long waiting times	Shuttle transport system
	Peaks of crowded areas	Previous day registration and form filling

Also, some diagnosis was started in the transcription room, which receives all doctors' tape recorded exam reports, in the attempt to identify error patterns and improvement opportunities, but that was left to future projects.

The interview guide (attached after references section) covered not only the eight categories/elements of Lean implementation success (Eaton and Phillips 2008): – communications; resources; involvement; training; implementation; compass; achievement; and leadership but also, waste (*muda*) identification and implementation enablers and inhibitors. The main findings in each category are summarized in Table 3.

Table 3 Summary of case evidence per category

Moment	Category	Case evidence
AS IS – before *Kaizen*	• *Muda* identification	Waiting times
		Excessive number of customer visits per exam
		Space waste
Kaizen project (5S *Gemba*-kaizen workshops)	• Communication	"Freedom of speech"
		Coaching method
	• Resources	Small investment in materials
	• Involvement	All hierarchic levels
		Other units "improvement agents"
	• Training	Lean tools and techniques in a simplified way (5S, visual control, kinds of waste)
	• Implementation	Team work
		Weekly achievements
	• Compass	By the schedule consultant's responsibility
	• Enablers	Top management involvement "thirst" of novelty
		Multi-professional teams
		Involvement of all hierarchic levels
	• Inhibitors	Cost pressures
		Resistance to change
		Rotation of workers between units
		Lack of results monitoring
TO BE – after *Kaizen*	• Achievements	Staff morale increased
		Time reduction (customer waiting times, full process length)
		New Kaizen daily vocabulary
		Poor customer perception of improvement
		Improvement opportunities discovered
	• Leadership	Expectations related to the consultant failed
		Strong role of operations management

6 Conclusions and Future Research Suggestions

This *kaizen* project case first driver was to start a journey to create a common way of working among 21 different units with different management heritages. The plan was starting in the "biggest" and "oldest" unit with some external help and then replicate to the other units with trained *senseis*. That goal was not achieved.

Answering the first research question – **What are the barriers to Lean implementation in healthcare?** – this case presents as barriers to lean implementation not only the change resistance and returns to comfort zone, both well solved during *kaizen* sessions, but mainly the discontinuity of *kaizen* program not extending to all the other clinical units. This works as barrier as the organization doesn't seem committed to complete the *kaizen* goals, letting the first event look like a mere experiment. Financial reasons alleged also worked as a barrier, being the external help of the consultants the main force of engagement, compass and leadership of the process. It lacked the internal leadership and *sensei* training. That interruption of work and mind set could be avoided by adopting a team-based approach: – why not have an inside permanent *kaizen* team to identify error patterns and improvement opportunities?

Let's now focus in the *Kaizen* project achievements. The second research question – **What enables Lean implementation in healthcare?** – was answered by the evidence of a well conducted and succeeded *kaizen* event. According to the literature, quick-wins are themselves the first enablers to achieve a lean mind set. However, all the enablers found in this first project (Table 3) were not leveraged by continuous deployment. Whereas implementation was quite easy, the long term sustainability seams jeopardized by the inexistence of leadership at all hierarchic levels and audit and monitoring system. That led us to the third research question – **How to develop a sustainable Lean culture?** The case evidence regarding the sustainability keys: (1) strategy and alignment; (2) leadership; and (3) behavior and engagement, was fable or non-existent leading to the conclusion that apart from the engagement of this first team seduced by novelty, no real long-term strategy was defined and, as consequence (or because of that), no leadership skills were shown in all hierarchic levels. Teaching people the tools and techniques is one thing, getting them to apply them in their working areas takes a mind-set of self-continuous improvement that leads to cooperation in sustaining the first quick-win achievements, so all the organization can play the same tune and not individual notes. It takes more than just training to have a real change process; otherwise it is just cosmetic or housekeeping. In this reported case the cosmetic wasn't even clear to the end customer. Auditing was required (three or four annual sustaining audits per work area, according to the literature) to achieve the fifth S. But sustaining actions must be pursued in daily basis.

Dealing with people in changing environment is, therefore, dealing with the "eight waste", the human potential that was not completely taken into consideration. And it is also managing the emerged information in a continuous improvement mind set.

Nevertheless, this case can be seen as a good start of Lean deployment if it has further development. Otherwise it was just a big waste.

In spite of being supported by a single case study, the followed approach and the research design enables replication it in other units of analysis with same inclusion criteria. It will be useful for the predicted future *kaizen* projects for this or other organizations.

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Part VII

Value Chain Models: Supply and Value Chains

Chairs:

Thomas Klumpp
Tomas Nord

Servicing Individual Product Variants within Value Chains with an Ontology

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Abstract Today companies have to satisfy manifold and changing customer demands. However, the question why and under what circumstances certain product variants cause performance problems within value chain operations remains unsolved. Existing process descriptions, data-models and IT-systems are remarkably supporting planning and optimization efforts, but show significant deficits regarding the integration of heterogeneous internal and cross-company systems. Relevant issues such as the evaluation of demand variety impacts on the subsequent value-adding steps in the value chain are not sufficiently solved. Ontological modelling could notably advance the information exchange in complex value chains and thus enhance value chain flexibility through a semantic harmonization that enables faster and faultless information flows between companies. Further advantages are the distinct reusability, modifiability, extendibility and shareability of ontology-based value chain models and software. Despite a distinct need to advance cross-company integration, ontologies are used in supply chain

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, DOI 10.1007/978-3-7908-2747-7_17,

management only occasionally. The need for methodical enhancement is high. Thus, the objective of this paper is to investigate obtainable benefits of ontological modelling for supply chain management (SCM) – here substantiated by means of a methodological support to improve product variety management in value networks. We provide a literature review, a conceptual framework and an implementation-guide for use in scenarios that represent the problems mentioned. The project-design was developed in an explorative feasibility study based on the sample case of an Austrian manufacturer. An achieved managerial insight that extends current SC-ontology contributions is a conceivable approach on how to gain a proof of concept for cross-company ontology application in value chains.

Keywords Ontology based modelling • Product variety • Supply chain adaptability • Supply chain ontology • Supply network modelling • Value chain ontology

1 Issues for Value Chain Management in Volatile Environments

Accelerated technology and product cycles, scarcely predictable markets and increasingly complex business interdependencies have significantly intensified the management challenges for most enterprises. This especially applies in the case of a highly individualized customer demand. Thus, short lead and reaction times constitute critical success factors in spite of high product variety in order to achieve a distinct operational flexibility (Stevenson and Spring 2007) and a proficient capability to adapt to structural changes (van Hoek 2004).

As the term "value network" implies, industrial value creation is based on a highly fragmented division of labour between legally independent companies, each concentrating on their specific core competencies. Depending on the respective products, technologies and purchased parts, the material flow may be convergent, linear or divergent, thus establishing a dynamic operational network topology. Despite the fact that there will be only few un-ramified network structures (supply "chains" (SC)), we also use the practically more established term supply chain management (SCM) for the corresponding management approaches and methods. Whenever the terms SC or "supply network" are used, a network-oriented understanding is implied which includes supply side and sell side processes (for detailed definitional discussion see e.g. Christopher 1998). Another relevant area in this context is logistics. The present article follows Mentzer et al. (2004) who classify "logistics capabilities" into demand- and supply-management capabilities and emphasize the importance of interface and information management proficiency based on a comprehensive literature analysis. In doing so, the authors distinguish between internal functions and cross-company cooperation.

Ontology-based data modelling techniques are used in an enterprise context to develop a standardized terminology for the description and subsequent computation of enterprise entities, relations, functions and rules. Although a unified vocabulary could provide substantial benefits also in a value chain context – for instance a uniform nomenclature of product variants and dedicated purchased parts within the companies that are involved into production and delivery – the use of suchlike harmonized cross-company knowledge domains is not yet common.

In order to adequately design, plan, control and optimize the relevant material-, information and financial flows within a value network, a company has to carry out a comprehensive bundle of tasks that could possibly be facilitated through ontological modelling:

- *SC-differentiation and SC-design*: provides an optimal platform for efficient and effective SCM (Persson and Olhager 2002), e.g. through configuring supply and distribution partners and flows.
- *SC-planning*: aims at the coordination of materials and resources in a supply network, taking into account customer service requirements and cost issues (Kok et al. 2003).
- *SC-execution and optimization*: subsumes all tasks related to order processing, e.g. production and transport activities (Beckmann 2004) and its improvement.

An important overall issue is SC-integration, defined as collaborative coordination of material-, information- and financial flows (e.g. Christopher 1998). Figure 1 describes the SCM-understanding applied in this paper at a glance.

Figure 1 illustrates how SC-differentiation can be done: the dotted line distinguishes companies with a high relevance for the acting company's operations (dark grey shading). All other companies – irrespective of whether there is a direct

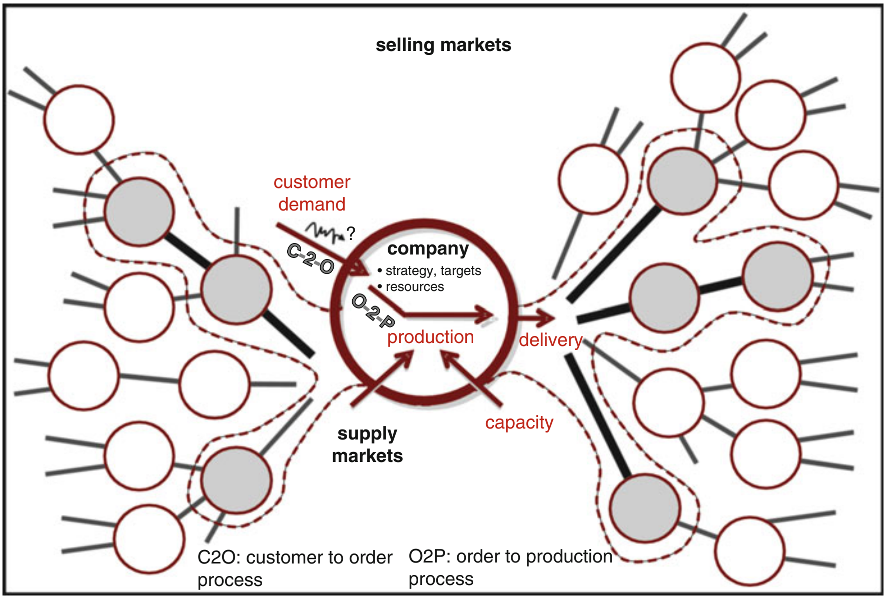

Fig. 1 Applied SCM perspective

contract with the acting company or not – are treated with low priority. The acting company has to decide how many (and which) customers and suppliers have to be managed with high attention. If a certain product variant needs to involve specific suppliers with a replenishment lead time greater than others or poor delivery reliability, this variant causes structural disadvantages for the value network performance, flexibility and response time compared to other variants. A cross-company unification of terms and nomenclatures (e.g. part numbers, product variant identifiers or machine scheduling-related information) through the application of ontological modelling across the relevant network would be highly supportive to accelerate the necessary coordination for proficient customer responsiveness.

We further assume that managerial decisions are not taken by an abstract construct as "a supply chain", but rather in each single company. Hence, a value network is a heterarchical system (e.g. Ahlert et al. 2009) consisting of actors (the companies, represented through knots) with a differing degree of influence on the network. The links between the knots represent cross-company cooperation. In the literature it is often said that SCs compete with SCs (e.g. Wu et al. 2009), though this is a misleading interpretation unless a bundle of companies negotiates an agreement to act as a strategic alliance, either constituted formally (contract) or informally (e.g. working committee) and aligning their decisions among each other (thereby actually creating a new SC arbitration entity). Although this happens (e.g. a retailer cooperative) a predominant handing over of decision power, away from the acting companies towards the established alliance will be an exception.

Following this argument, a unique value network conceptualization that is notionally shared by all, or at least by the majority of its members, the companies, can't exist. We rather assume that each company (or more accurately each single decision-making unit or person) builds its own subjective value network model, which will always be an incomplete and subjective excerpt from the existing reality. Those subjective network models will overlap with each other, partly contradictory, partly corresponding. What, in contrast to those multiple network conceptualizations, really exists, are the physically occurring material, information and financial flows in all stages of value creation. Figure 2 shows: each company establishes its own SC-view. Some will do so systematically, e.g. through SCM. Others act intuitively, but still have an implicit conception of the surrounding business.

An important conclusion from Fig. 2 is that a harmonization of vocabulary and interpretations is essential to jointly advance the value flow performance. This is also supported in the literature: e.g. Brock et al. (2005) are claiming flexible, ideally even dynamic means of description in order to enable individual parties to construct their own particular views and to facilitate the interoperability between them. A further effect is that different SC-actors will use different notations for similar coherences. Another frequently occurring consequence is a conflict of objectives, e.g. a differing rating regarding the mutual importance in a vendor-customer relationship (companies A and B in Fig. 2). This reciprocally diverging perception of the same SC-partnership may negatively impact the course of business beyond a

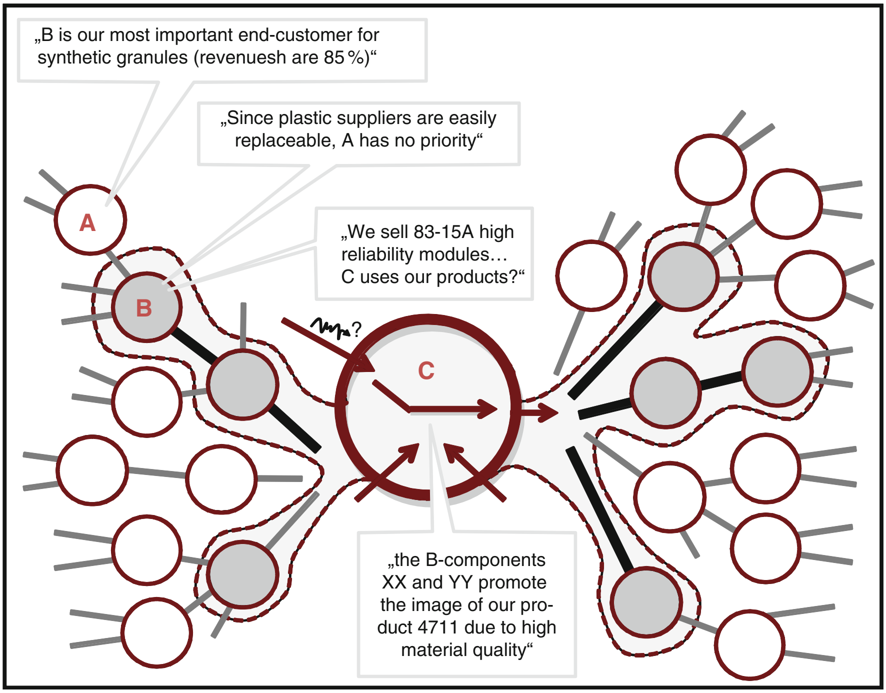

Fig. 2 Heterogeneous SCM perspectives within the fictitious companies A, B and C

differing terminology. Operating a business in this context is a managerial challenge that has to be methodically well-supported. Cross-company ontological modelling offers promising potentials but needs further investigation. Thus, our research question is: *can ontology-based modelling techniques support the challenge of determining why and under what circumstances certain product variants cause structural performance problems in value chain operations?*

The paper is organized as follows: Sect. 2 presents a thorough literature review. Section 3 discusses necessary implications from a value network perspective with a specific focus on the issue of SC-impacts caused by product-variety. Section 4 describes the methodological foundation for the use of ontologies in the given context and explains the applied project design. Section 5 contains the conceptual framework that has been developed in the course of a feasibility study, carried out in an Austrian company, referred to as “Basic Value Chain Ontology” (BVCO). The BVCO is later used as a fundamental base to further investigate product variety impacts within SCM. Section 6 presents an implementation guide deduced from the feasibility study results and the previous conceptual findings. We conclude in Sect. 7 with a short reflection on achieved findings and managerial insights, mention possible limitations and indicate future research needs.

2 Literature Review

2.1 Literature Review Approach and Search Methodology

The use of ontological modelling techniques in a SC-context has been discussed in the literature only occasionally. A search in 12 recognized SCM-journals (peer reviewed, Menachof et al. 2009) with rather generic search strings ("ontolo* & supply chain", "ontolo* & value chain", "ontolo* & network", "ontolo* & system", "ontolo* & logistic*") resulted in 66 matches. A qualitative content analysis (Flick 2010) yielded only seven relevant articles: either the term "ontolog*" was contained but used in a broader philosophical sense or ontology was a side-issue, mentioned in another context (e.g. semantic web or multi-agent systems, cp. Cauvin et al. 2009 or Lo et al. 2007). Thus, as a second step, a more explorative research was enclosed, omitting the journal constraint. The quality of matching articles was, however, made sure, by restricting the search to academic databases (ScienceDirect, EBSCO and Emerald). Again a qualitative content analysis was conducted, filtering out 13 additional relevant contributions, the majority of them being published in journals related to computer science. The third step of the literature review was based on a recent and rigorously set up SC-ontology review, conducted by Grubic and Fan (2010). We also used sources identified in this review.

A possible limitation might result from the fact that the presented literature review is not exhaustive, but selective. For instance there could be relevant publications in further languages. Also, other databases might contain valuable articles. Further, contributions that do not explicitly address a SC or value chain context might still implicitly refer to a comparable setting, e.g. using paraphrases such as "inter-organizational context", or directing their focus on analogue topics such as the virtual enterprise (see e.g. Rajan 1996 or Presley and Liles 2001). A search logic that completely respects such matters is too manifold to be practically applicable. To best possibly overcome this kind of bias with a still feasible review approach, as a fourth step singular broader queries were executed in an explorative manner with generic keywords such as "enterprise ontology", again conducting a qualitative content analysis within respective matches to select valuable contributions for the use in the present paper. Finally the reference lists of all articles selected within the steps 1–4 were evaluated for further continuative traces, again enhancing the literature base for the present review.

2.2 Ontology Application in a SC-Context: Literature Review Results

The term ontology originates from philosophy, there indicating assumptions about the existing reality (Burrell and Morgan 1985). As e.g. Masuwa-Morgan and Burrel (2004) or Metaxiotis et al. (2001) show, the term ontology is meanwhile used heterogeneously. "Ontology" in an epistemological context constitutes the essence of a knowledge domain, e.g. logistics or value chain management, investigating its nature, inherent paradigms, theoretic laws and conceptual grounding. Contrariwise, if applied in the field of ontological engineering, an "ontology" refers to a formal semantic structure that "codifies features of things" (Gómez-Pérez et al. 2004, p. 5). In this regard a "SC-ontology" incorporates SC-related entities (such as products, parts, customers, suppliers etc.), relations between them and rules regarding their interaction. A more detailed ontology definition for the context of the present article is proposed in Benjamin et al. (1995), who state that an ontology describes physical and conceptual things that characterize a certain domain in terms of their properties and mutual relationships, using a formal language to establish the respective domain-specific terminology. In this regard Mentzer et al. (2004) emphasize the role of logistics theory (like any theory) to provide an ontological framework. In particular process modelling techniques are regarded as beneficial to establish integrated business rules, processes and organizational enterprise views (Presley and Liles 2001). As relevant shortcomings in a cross-company context Presley and Liles emphasize lacking capabilities to apply multiple enterprise views and insufficiencies regarding a top-down process design. Subsequently, several research initiatives have developed enterprise ontologies (e.g. Fox and Gruninger 1998). However, as the literature review shows, such attempts have not yet resulted in a broad dissemination.

A basic SC-ontology is presented by Tsou (2008) who in turn uses a generic SC-model (Lambert et al. 1998) to provide a building block for SCM. However, the model granularity remains generic. A similar approach is chosen by Ye et al. (2008a, b) who apply a higher degree of concreteness. A comprehensive comparison of SC-ontologies is presented in Grubic and Fan (2010). This analysis is of specific relevance not only because it presents a comparative discussion, but because of the given comparison criteria. Grubic and Fan state that SC-ontologies have not yet been successfully leveraged regarding SC-interoperability.

A close coherence to SCM is also found in Yoo and Kim (2002) who emphasize the issue of heterogeneous information resources in a world with proliferating network character. Yoo and Kim specify three types of knowledge: metadata, ontology, and the mapping of relationships among varying data formats. Lee et al. (2009) argue that the semantic interoperability of product information is a necessary cooperation enabler. Similar, Im and Rai (2008) define an "ontological commitment" as the reliance of partnering firms on digital objects to facilitate inter-organizational knowledge sharing. The ability to exploit value chain related information is a critical success factor, since the lack of a common taxonomy is a main obstacle for SC-integration (Anumba et al. 2000). This is confirmed in Brock et al. (2005) who criticize the lack of mechanisms to describe and integrate diverse models. Further global interoperability standards (e.g. EAN, SCOR or from an IT-perspective EDI, XML) are highly important for SC-performance. A conceptual list containing such categories is found in Boardman and Clegg (2001) who distinguish process-, SC- and industry architectures. However, an ontology can accelerate network information flows on two conditions only (Brock et al. 2005):

Table 1 Logistic or SCM-related application of ontology based modelling techniques

Author(s)	Focus of ontology application	Sample application
Metaxiotis et al. (2001)	IT-enabled order sequencing and scheduling are important, but can't be handled as flexible as needed due to high complexity; ontology is used to improve information sharing and reuse across applications	Production scheduling (case study, manufacturing)
Smirnov et al. (2004)	Configuration of a collaborative SC as a dynamic, flexible and agile system through the use of ontologies as a supplement for other quantitative methods; ontological task description and decomposition	Request ontology (case study, car manufacturing)
Chandra and Tumanyan (2007)	The initial argument for an ontology model is the need to share knowledge among SC-parties; a generic SC-ontology is developed including an ontology server organization to facilitate the reuse of software	Generic SC ontology and sample application (steel)
Seng and Lin (2007)	Ontology-assisted analysis method and model to facilitate the cross-company implementation of a BSB e-commerce standard specification on a syntactic and semantic integration and interoperability level; the underlying intention is improved automation between domains	Ontological B2Be-commerce specification (prototype architecture)
Giménez et al. (2008)	Due to computational limitations and forecasting uncertainties, the use of product information on a planning level within MRP-concepts and based on the bill of materials faces several problems; based on a structural product hierarchy a cross-company ontology is developed to handle different information types on different granularity levels	Product-related ontology for logistics planning (case study, candy production)
Lee et al. (2009)	In most value chain environments the sharing of product information among enterprises shows insufficient interoperability; a product ontology architecture shall facilitate the building of product ontologies during different stages of a product life cycle	Product ontology architecture, cases (washing machine/ automobile)
Peng and Nunes (2009)	The adjustment of ERP-systems within on-going operations is a complex issue, associated with a number of risks; a respective risk ontology facilitates risk identification and management	Risk ontology for ERP systems (desktop study)
Chi (2010)	Develops an ontological knowledge model of a supply network, defines properties, relationships and semantic rules; presents an example from the solar industry; concludes improved agility through advanced partner tracing abilities in commercial collaboration	Partner tracking in supply networks (model, solar industry sample)

semantic precision and established semantic links between different logistic models. Each entity has to be defined uniquely. Further consistent relationships and rules are needed, despite the dynamic and heterogeneous nature of value chains.

Otherwise an ontology application might not yield expected benefits (Lee et al. 2009).

Another contribution that explicitly applies a supply network perspective is a recent study conducted by Chi (2010), who claims agility improvements through an advanced partner-search in the face of unsteady objectives and a varying, complex link-topology. Further contributions associated with logistic or SCM are displayed in Table 1.

Overall, the literature review showed a broad consensus regarding the motivations for the use of ontologies in value chains. Although the number of actual high-quality publications is low, a number of generic SC-ontology approaches could be found. Further, several specific SC-related issues have been modelled using ontologies (Table 1). Both types of papers are either of a conceptual nature partially supplemented by a practical example or have achieved their practical findings through a case study. A broad business experience has not yet been described for any identified approach. Thus, it can be assumed that a more intensive practical application might lead to further findings e.g. regarding necessary implementation prerequisites or possible complications.

3 Variety Issues in SCM

Increasing product variety is a widespread SC-phenomenon because of manifold and diverse company-external and -internal influences. One apparent external reason is the pressure to meet sophisticated and individual customer requests within shortening delivery time frames (cp. the literature review in Kohlberger et al. 2011). This is particularly relevant in markets that show the following attributes:

- Customer-specific business (make to order) with multiple product variants and a low chance to sell finished products elsewhere (e.g. Thonemann and Bradley 2002, Vaagen and Wallace 2008). Here, demand variety not only concerns the delivery of goods but also service markets (e.g. Salvador et al. 2002, Vaagen and Wallace 2008 or Scavarda et al. 2009)
- A horizontally and vertically fragmented value chain topology that leads to intensive cross-company negotiations, being tightly integrated with production planning and therefore requiring appropriate decision support (e.g. Calosso et al. 2003 propose to establish a negotiation ontology between firms)
- Customer expected lead times are equal to or shorter than a company’s ability to fulfil an order (a problem which can partially be compensated with strategic stocks); this issue becomes increasingly severe with rapidly emerging technologies and shortening product life cycles (e.g. Vaagen and Wallace 2008)
- Volatile and scarcely predictable demand inhibits preventative counteractions such as planning, stock building or preproduction (e.g. Kohlberger et al. 2011)

Additional internal influences are data transparency and value network structure (Franke 2002). In order to avoid variety-caused performance deficiencies, e.g.

delivery shortages or excess inventory, it is most important for a company to establish a transparent and adaptive variety management (Kohlberger et al. 2011). Especially unpredictable make to order businesses require the capability to quickly react in the face of changes and – ideally – to be able to anticipate which variants are predominantly inappropriate in terms of their influence on the SC-performance. Here ontological engineering has promising improvement potentials in the following respect: if multiple product variants can be universally mapped from the point of sales perspective (demanded variant, obtainable revenue, customer required lead-time) across internal production (impacts on lead-time, utilization, inventory and costs) onto the corresponding purchased parts (determined through replenishment lead-time, supplier reliability, costs etc.) predominantly using unified terms and ontological rules, a flexible identification of inopportune variants becomes possible and could be subjected to managerial countermeasures such as due date postponement, avoidance of certain variants, establishment of strategic inventory buffers, sales price negotiation or even supplier substitution.

4 Ontology Application in a Value Chain Related Context

Section 4 discusses potentials of ontologies in this context (Sect. 4.1). Subsequently a two-tiered implementation path is developed for the case of the mentioned industry partner (Sect. 4.2).

4.1 Ontology Constituents

The most powerful and highly developed ontology definition language is the "Web Ontology Language" (OWL), which was recommended in a final version by the W3C consortium in 2004 (McGuinness and van Harmelen 2004). OWL offers three main concepts for ontology modelling: class, property, and individual. Lacy (2005) and Horridge et al. (2004) describe them as follows:

Classes can be interpreted as sets of individuals. They are defined by rules that state precisely the requirements for membership of the class. Classes are organized into a superclass-subclass hierarchy, a so called taxonomy. A subclass is a specialization of this superclass, while a superclass represents a generalization of all its subclasses. All properties that are defined for a superclass are recursively inherited to all subclasses (Horridge et al. 2004).

Lacy (2005) defines a *property* as a binary association that relates an object to a value. This value might be a simple data value or another object. Properties that refer to a simple data value, like a numerical value or a string, are called data-type properties. They can be compared to attributes we know from relational databases or object-orientated (OO) design paradigms. Properties referring to another object are called object-properties. They can be seen like relations in relational databases.

Individuals are instances of a class, or if classes are seen as a set of individuals, their members. They often describe physical or virtual “things” like persons, products, parts, programs, ideas etc. They correspond to records in a relational database or objects in OO design.

Besides the definition of data structures and relations OWL offers tools to model rules for checking the validity of individuals. These rules are integrated into class definitions and can be checked by automated reasoning components, so called reasoners. Several open-source reasoning components are available for checking an ontology’s consistency and rules. The most important reasoners are Pellet, RacerPro, and FaCT. A comparison and benchmarking of these and others can be found in Weithöner et al. (2007).

Since OWL is a wide-spread standard, a number of graphical editors and software tools exists which further enable the construction of ontologies and ontology-based applications. The most advanced ontology editors are the open-source project Protégé, which is presented in Horridge et al. (2004) and its commercial version Topbraid Composer. For accessing the ontology information directly, numerous application programming interfaces (API) were developed, first to mention the open-source project “Jena API”, which is described in Carroll et al. (2003).

Ontologies can contain complex data structures with a large number of individuals. Hence, a special query language, SPARQL, is provided. It was officially recommended by the W3C consortium in 2008 (Prud’hommeaux and Seaborne 2008).

The OWL can be seen as a meta-data model. Software that builds upon this model instead of upon the instantiated data model becomes more adaptive and generic. Hence, using OWL for data definition allows the development of domain independent software components. Especially for the present application that intends to more effectively analyse the impacts of a certain product variant on the attached value creation steps, this incorporates notable advantages: changes that become necessary due to demand fluctuations, changing production conditions or raw material market shifts, could be efficiently and timely adjusted across all participating companies of the relevant value chain segments. The existence of numerous APIs enables this development.

4.2 Case Study Approach and Research Design

According to the mentioned potentials, Sect. 4.2 describes the implementation approach of this research project. The respective Austrian manufacturer operates in a complex value network in a make to order setting and seeks closer links to its end-customers to better manage the existing product variant range and unexpected demand variations. The dependence on currently ~1.500 retailers is too high, coming along with poor value network transparency. Thus, an integrated planning of capacities and supply flows is nearly impossible. Current measures for easing demand are insufficient. Lead times and supplier replenishment lead times are too long for market requirements. The company's and their supplier's adaptability needs improvement. According to the theoretical findings preparatory existing practical work at the company site, the research team applied a 4-step approach:

Step 1-value network transparency – a "Basic Value Chain Ontology": since semantic company-interoperability is an indispensable prerequisite for further project progress, first a basic ontology-framework had to be established to enhance the case company's point of view and transparency towards external SC-parties (retailers, end customers and direct suppliers). This basic ontology concept was developed within a feasibility study and is explained in detail in Sect. 5. In contrast to the generic SC-ontology models referred to in the literature (see Sect. 2) the developed "BVCO" was modelled on a rather concrete level of detail.

Step 2-product variant configuration – case-specific in-depth ontology: based on the broad understanding and network transparency achieved, step 2 will include the detailed modelling of an exemplary product variant hierarchy within the case company's product portfolio. The objective of this step is to achieve a sufficient knowledge regarding structural deficiency causes of inopportune product variants. Thus, in contrast to step 1 a small, but deep-reaching and company-specific analysis focus was defined (also cp. the in-depth case examples in Table 1). Due to the inherent nature of ontologies to be easily adaptable, a transfer to other products, companies or domains within further projects is a feasible option. The resulting research path to develop and implement this advanced product configuration ontology is described in Sect. 6.1.

Step 3-software facilitation – a "smart" product configurator: since the case company has the ambition to achieve a smoothly integrated, flexible and efficient value chain flow and at the same time a major benefit of ontologies lies in the facilitation of easily adaptable software application, step 3 will concentrate on the definition of a "smart" product configurator software that was considered to be the most effective means for further advancement within the feasibility study. Based on the overall network transparency (step 1) and the detailed product variant hierarchy (step 2), again ontologies will be used to facilitate this intention. Section 6.2 presents the currently defined functional requirement specifications. The fundamental design principles are to first identify inopportune product variants (using the ontological models from step 1 and 2) and to second exclude or compensate additional cost of such variants though a higher sales price.

Step 4-ontology-based enterprise integration for optimization purposes: in order to best possibly exploit ontology benefit potentials, the achieved semantic harmonization will be further used for process optimization. A typical problem that also occurs in the case company is a lack of cross-department communication, especially regarding construction/engineering, purchasing, logistics/production planning and sales/marketing. The future use of a common vocabulary is assumed to effect significant performance and financial advancements.

5 Feasibility Study: A "Basic Value Chain Ontology" as Conceptual Framework and Implementation Prerequisite

Section 5 explains the exploratory feasibility study, conducted in the course of step 1 (Fig. 3): the conceptual ontology-framework that has been developed for the context of the case company, here referred to as "Basic Value Chain Ontology". The BVCO will be subsequently used as the fundamental base to approach product variety issues within SCM (steps 2–4 in Fig. 3, presented in Sect. 6).

According to Methontology (Gómez-Pérez et al. 2004) which is assessed to be widely accepted (e.g. Pinto and Martins 2004), there are five essential stages during the process of ontology building: specification, conceptualization, formalization, implementation and maintenance. These stages are based on evolving prototypes because Methontology allows adding, changing, and removing terms in each new version. Following this approach, the ontology creation (here the BVCO) in the course of the current practical case was carried out as follows:

Specification: the scope and purpose of the BVCO were defined as threefold: the first intention "*network transparency*" was to achieve improved SC-transparency by establishing a solid base for a uniform cross-company terminology even though in practice each company (independent of their role as a supplier, customer, service provider or other) uses their individual terms and expressions (step 1 in Fig. 3). The second intention "*product variety impacts*" was to thereby enable a smooth drill-down and roll-up regarding the granularity of product variants (step 2 in Fig. 3). The third and last intention "*internal comprehension*" was to achieve a superiorly integrated communication and calibration base between the departments responsible for improvement measures. For the current case especially

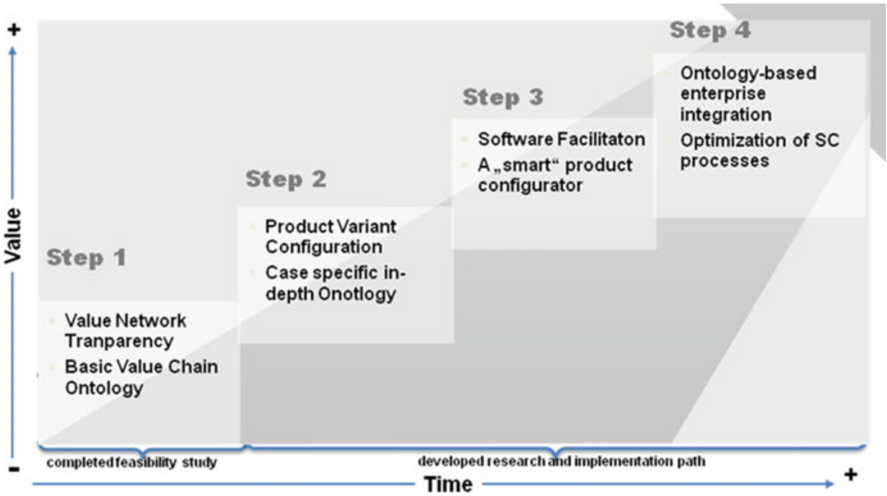

Fig. 3 Two-tiered approach: feasibility study and future research/implementation path

representatives from construction & engineering, purchasing, logistics & production planning and sales & marketing had to be conjoined within this third focus point. In order to "not lose" the understanding and participation of those team members that were not experienced ontology experts, during the phase of objectives definition the overall approach was verbally simplified into a "means to achieve improved value network transparency and cooperation through a standardized and shared vocabulary" (also cp. Guarino 1998 for this definition).

Conceptualization: the BVCO model construction was done within expert workshops in an interdisciplinary team to cover a sufficient knowledge regarding

- the business operations and strategic intentions of the case company
- a deep understanding of logistic, SCM-issues and related ERP-knowledge
- a sound proficiency within the development and application of ontologies.

Thus, the relevant concepts, entities, attributes, relations and rules were defined. Since the domain experts in the team also gradually gained a broader idea about ontologies, the used modelling terminology was specified further as "a commonly agreed view of a domain which is characterized by easily extendable and adaptable attributes, relationships and domain rules regarding a certain issue". According to the envisaged aspect of product variety the first prototype of the ontology was focused on the variant parts list. This data-driven view of the relevant reality also supports the intended product configurator. The correspondent classes were defined on the basis of OO modelling techniques (Staud 2010). The also discussed process view has not yet been made explicit in the ontology.

Formalization: the subsequently required transfer into a formalized model was done by modelling experts who iteratively calibrated their results with the technical domain experts for validation and verification purposes. Our first ontology prototype contains six classes at the top level. The central class of this ontology is Unit. A unit is described by a number of numerical attributes like the number of working steps. It contains a transitive relation to itself named consistOf. This relation enables the user to describe the complete parts list of a product from major assembly groups down to the singular parts. It creates a hierarchical structure of units being parts of other units in the next hierarchy level. The transitivity of the relation alleviates the determination of complete parts lists for a certain unit, which can be a product or an assembly group. Furthermore, the relations isStoredIn, isFinalizedIn, and is ProcessedBy define the inventory location, the allocation of manufacturing resources, and the working steps of a unit. Since the number of factories involved in the production process is an important characteristic for the case company, each working step is assigned to a certain factory. Each factory is assigned to a location and a party. Hence, it is possible to determine how many external resources are involved in the production process for each unit.

Further, location information and corresponding geographical details are attached to each inventory. This information can be used to optimize logistic processes across the value network. Figure 4 shows the developed conceptual model.

Figure 5 shows an excerpt of the specialization (to be completed in step 2, see Sect. 4.2) of the already described base ontology in Protégé: as mentioned before, the specialization mostly affects the class *Unit*. It describes the parts structure of an agricultural machine manufacturer. A *BroadDiscMower* is a *DiscMower*, a *DiscMower* is a *GrasslandProduct*, a *GrasslandProduct* is-a *Product* etc.

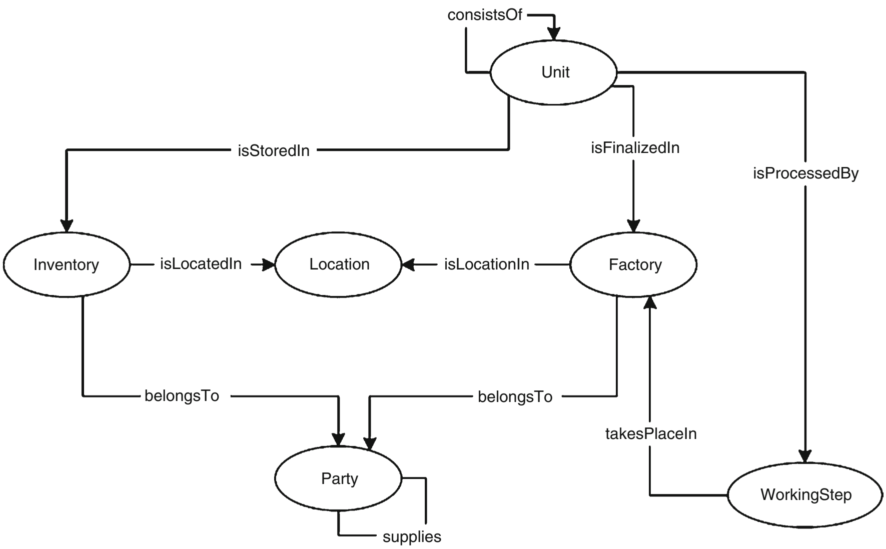

Fig. 4 Basic value chain ontology (BVCO)

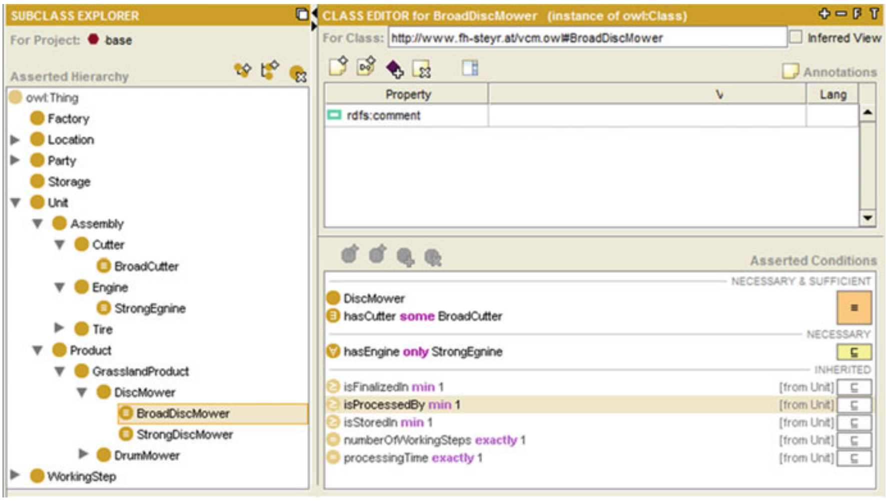

Fig. 5 Excerpt of class-hierarchy and -restrictions

In the right-lower panel the restrictions, which model the valid product variants, are defined. A *BroadDiscMower* is any DiscMower that has at least one (some) *BroadCutter*. So this restriction ∃ *hasCutter some BroadCutter* stated in the Necessary and Sufficient area defines the membership of the class *BroadCutter*. Furthermore, *all* members of this class have to fulfil the restriction defined in the Necessary area. Only engines that are defined as strong engines are allowed with this kind of mower.

Implementation: the formalized ontology was automatically implemented into OWL by Protégé.

Maintenance: this stage (set-up and coordination of the continuous ontology updating) had not yet been implemented at this early phase of the project.

6 Future Research Path and Practical Implementation Guide

Section 6 describes the forthcoming case-specific constituents. The antecedent feasibility study and development of the basic ontology (Fig. 4) has proven to be a valuable step, since now the common understanding of the involved domain and ontology experts has remarkably advanced.

6.1 Company-Specific Product Configuration Ontology

For a company-specific product configuration ontology the base ontology (Fig. 4) has to be extended to fit the company's structures and product-configurations. This specialization-process mostly affects the class *Unit*, which is a generalization of all products, assemblies, and individual parts that produced in a company.

Since the number of involved parts can exceed several thousand, the construction of the specific ontology is the most time- and effort-consuming step in ontology-based SC-modelling. But, given a properly structured, well defined, and electronically stored bill of materials, at least some of this work can be done automatically by batch scripts using database queries in an existing ERP-system. The construction process can be split up into three main parts, whereas each part is based on the results of its predecessor:

1. Creating a unit-hierarchy. Hierarchical organization of classes, also known as taxonomy, is deep-seated in ontology design. The generalization allows the definition of rules and attributes at a very high abstraction level and increases the clarity of the ontology. If the company's parts lists are already organized in a hierarchical structure, the ontology's class hierarchy can be created automatically. If there is no such structure, some time and effort is necessary to define at least a very simple taxonomy and try to automatically assign the individual parts to the corresponding classes.

2. Creating the maximum bill of materials. Once all parts are organized in a hierarchical structure, the parts list itself has to be modelled; meaning the possible sub-parts for each part are defined, using the generic relation consistsOf (Fig. 4) or derived ones. As in step 1, this can be done (semi)automatically, provided that the parts lists are stored in a clearly defined electronic way. The result is a maximum bill of materials, which defines all possible product configurations.
3. Defining rules for combination validity. Step 2 defines all theoretically possible combinations of products. Some of these combinations might not be valid because of incompatibilities (e.g. gasoline ignition plugs for a diesel-engine truck); some might just not make sense (snowplough mounting for a desert truck); and others might not be cost-effective. Rules are needed to distinguish between valid combinations and invalid ones. They are defined using OWL restrictions. Hence, they can be checked by automated OWL reasoning components, as described in Sect. 4.1.

All three steps can be very time consuming if there is no groundwork done. But each step yields a valuable result by itself, like a taxonomy of parts, a maximum bill of materials, or a system of rules for product variety.

6.2 *Ontology Based Software Facilitation – A "Smart" Product Configurator*

In the course of the feasibility study the project team decided that, among several other ideas, an ontology-supported product configurator is supposed to enclose the most extensive improvement potential for the following reasons:

- Achievement of a newly established link between the company and their end-customer (who until recently has communicated mainly with the intermediate distributor); the main challenge for this modified network structure is to create a common awareness between three involved value chain stages – producer, distributor and end-customer – that the main intention is to intensify a triangular information exchange without any intention to pass over or exclude the distributor. Far from such fears, the distributors have currently got and shall henceforth retain their important distribution, advisory and service role
- Advantage of higher network transparency due to an inter-organizationally shared and standardized vocabulary; in addition to this, the opportunity to intensify and accelerate the information exchange in order to first of all improve flexibility towards customer demand changes and secondly avoid dynamic value chain phenomena such as the unfavourable bull-whip effect
- The first-time facility, to integrate information flows beyond the common dyadic focus between more than two SC-parties as well on a syntactic as a semantic level by means of creating a new permeability along the material value flow; as a

most important presumption for such attempts the product configurator will have to provide the ability to define rules regarding the logistic advantageousness or disadvantageousness of certain product variants

- Using an open standard definition language like OWL for ontology description results in an openness of the system against new participants. Furthermore, it allows the use of standard tools for ontology description and maintenance. Standard libraries and APIs for OWL can be used to decrease the development effort and time of ontology-based software products.
- Ontologies provide, besides the stored data itself, information about the data structure. Hence, they can be seen as a meta-data model. Common data-based software is usually programmed against a constant data model. Changes in this model cause multiples (expensive) changes in the software. Meta-data based software is based upon the meta-data model, which contains the actual data model and the corresponding data. Changes to the data model (stored in the meta-data model) don't affect the software any more. This is particularly important if the customer demand is volatile and if there is a frequent replacement of entities – such as product variants or parts but occasionally also suppliers.

The notation "smart" for this configurator was derived from these attributes. As an overall strategic advantage the distinct adaptability of ontology-based software application is assumed to enable the (then ontology-facilitated) value network to quickly adapt to all relevant levels of abstraction, including the important semantic layer. Since, to the best of our knowledge, this approach is complete novelty, elaborate cost-effort and risk analysis has to be done prior to implementation. Here, again, ontologies help to alleviate developing and prototyping. Ontology-based software is based upon the ontology as a meta-model, not upon the instantiated data model. Changes to the data model, are causing none or only minor changes to the software. So, in the beginning phases of the project no fully-fledged data-model is necessary. Iterative prototyping of the data model can be used here, which would cause severe problems in common data-based software applications.

Both, software and data model can be developed iteratively. As mentioned above, the existing BVCO will be a sound base for this endeavour, and will also have to be further advanced in the course of the further progression.

6.3 Ontology-Based Supply Chain Optimization

In the context of our case a well-working information exchange between the involved departments is most important for faultless and flexible operations. This applies for two specific issues: first the early integration of production, purchasing, logistics and controlling representatives already during product development and second continuous improvement. Although the literature strongly recommends applying early involvement approaches (e.g. Narasimhan and Das 2001), in practical environments the cross-departmental communication often is poor.

Again the future project course intends to systematically exploit ontology benefit potentials, through the consequent integration of the aforementioned company departments. One could say that the thus technically enabled semantic harmonization, will be put into service of a more effective application of early involvement strategies. This will not only take effect within the use of a common vocabulary, but furthermore is expected to initiate notable process optimization measures yielding into significant performance and financial improvement.

7 Conclusion

The conducted feasibility study and the future research path show the potentials of ontologies to handle product variety issues within SCM. Besides semantic transparency in value chain coherences there is strong evidence from the case study that detailed modelling of a product variant hierarchy is practicable. At the same time easily adaptable software (here a configurator) can be implemented on an ontology basis. A "smart" product configurator that is able to indicate inopportune impacts of certain product variants on subsequent value creation steps is an absolute novelty within value chain management. Further we assume that the use of ontologies improves cross-department communication, in our case facilitating the product definition and development phase.

We consider evolutionary prototyping and thus the application of appropriate ontology tools as prerequisites for sustainable ontologies. This leads to "quick wins" and prevents the danger of getting lost in details. Since ontology engineering is complex and can lead to big efforts and organizational impacts, management support and consulting by ontology specialists are obligatory. Thus reflecting to the initial research question, we attest a strong evidence to approve the capability of ontologies to support the challenge of determining why and under what circumstances certain product variants cause structural performance problems in value chain operations.

As ontologies are not yet broadly established in value chain-related domains, further practical application might lead to enhanced findings. A potential limitation of our findings could derive from the fact that only one company was investigated in-depth. Therefore the portability of the developed concepts, procedures and software constituents has to be further validated. However, as shown above several valuable managerial insights have been attested based on the current findings. A distinctive and novel benefit results in particular from the sound level of concreteness and practicability that was achieved within the developed items.

Acknowledgments The authors wish to thank two anonymous reviewers for their valuable comments to improve this paper. The Upper Austrian Government has supported the research project AGTIL (adaptive value creation, integrating technological, sociological and logistical issues), in particular “ASC – Adaptive Supply Chain” that enabled the feasibility study in this publication.

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Offshorability Along the Value Chain: A Task-Based Approach

Hale Yilmaz

Abstract Rapid progress in information and communication technologies has led to a sharp increase in offshoring activities of various companies. Due to offshoring, firms can lower their production costs, enter new markets, and gain access to new resources. Recent theoretical approaches to explain offshoring are mainly task-based and do not differentiate between industries. This paper, in contrast, deals with whole chains in different industries, taking into account the technological restrictions. It analyses the characteristics of tasks for individual production steps in seven different industries, such that the offshorability of production steps for each of these industries can be ascertained. It shows that the production steps in the textile, timber, chemical, metal, electro-technology and automotive industries as well as mechanical engineering differ in their offshoring properties and that some steps cannot be offshored without up- or downstream steps also being offshored.

Keywords Offshoring • Production step • Value chain

1 Introduction

Recently, the offshoring of production, i.e. the relocating of production steps to foreign countries, has become increasingly important. Not only multinational enterprises enjoy the benefits of international production networks; also smaller and medium-sized companies are operating internationally. Fragmentation and relocation of production steps help companies to discover wage advantages across the world, to enter new markets, and to gain access to new customers or resources. Therefore, offshoring causes value-added chains to span the entire globe. For example, a German car sold in Asia can have its air-conditioner and engine made

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7_18,

in different locations in Europe and its interior and body produced in Asia. For a textile product, yarn can be spinned in Northern Africa, before it can be woven or knitted in East Europe and then the cloth can be tailored in East Asia. In this process, transport costs, unpredictable delays, the whole management of the supply chain are of utmost importance.

Theoretical approaches have tried to explain such relocation activities by looking at the offshoring costs for individual production tasks, regardless of which industry these belong to. However, in addition to the characteristics of individual tasks, industry-specific technological restrictions are also highly important criteria for the offshoring decisions of firms. The current paper employs an integrated approach to analyse these two aspects, and develops hypotheses on the offshoring potential in different industries, including the textile, timber, chemical, metal, electro-technology, and automotive industries as well as mechanical engineering.

Based on the studies of Blinder (2006, 2007), Levy and Murnane (2006a), Autor and Spitz-Oener (2003, 2006), and Leamer and Storper (2001), four different dimensions of offshorability are defined: transport requirements, communication requirements, task properties, and codifiability. Along these dimensions, a methodology was developed for evaluating the offshorability of tasks. This analytical methodology was applied to exemplary value chains.

Besides the analysis of the properties of tasks, the degree of technical restrictions between single production steps was taken into account to give an answer to the offshorability of these value chains. Therefore, this paper focuses on the production steps individually in different industries, in order to obtain a more industry-specific view of the offshoring potential. After an introduction and a short description of the theoretical background, the methodology of the value chain analysis is explained. This is followed by the analysis of the offshorability in various industries, such as the textile, timber, chemical, metal, electro-technology, and automotive industries, as well as mechanical engineering.

According to Blinder (2006, 2007), the properties of tasks can essentially be categorized as ‘impersonal’ or ‘personal’. Impersonal services have a higher offshoring potential than personal services because personal tasks require face-to-face contact. These dimensions, describing the degree of customer contact, are of utmost importance for the analysis of task offshorability. Furthermore, Blinder mentions the properties ‘location constraint, ‘physical presence’, and ‘routine’. Both location constraint and physical presence require the presence of labour. Therefore, they are combined in this analysis in the resulting attribute ‘production property’ that is adequately described by four different criteria: ‘automation’, ‘labour presence’, ‘customer presence’, and ‘location constraints’. Automation is described by activities that do not require physical presence and can therefore be easily relocated. Labour presence is needed for teamwork during production and refers to a minimum skill level. Employees must be able to communicate constructively with each other should problems arise. This required skill level makes it difficult to offshore the production activities. Customer presence results in an even smaller degree of offshorability. If customer presence is required, the relocation over larger distances is nearly impossible. The lowest degree of offshorability is achieved by location constraints. There is almost no potential at all for relocating production activities.

Both Levy and Murnane (2006b) and Autor (2003) and Spitz-Oener (2006) discuss five types of tasks with different criteria, such as ‘routine manual’, ‘routine cognitive’, ‘complex communication’, ‘expert thinking’ and ‘non-routine manual’, or ‘routine manual’, ‘routine cognitive’, ‘non-routine interactive’, ‘non-routine analytical’, and ‘non-routine manual’. Despite the different denotations, the two approaches are based on the same concept. The characterization of the ‘type of task’ is fulfilled through the attribute levels ‘manual’, ‘cognitive’, ‘interactive’, and ‘analytical’. Another attribute is the required ‘task skills’, which can be either ‘routine’ or ‘non-routine’. In addition, the authors define the characteristics of different types of rules. They can be associated with the ‘type of problem’. The problem is usually ‘deductive’, ‘inductive’, or based on a ‘pure pattern recognition’. Depending on the type of problem, the potential of a routine skill can be recognized.

The analysis of Leamer and Storper (2001) is especially focused on the ‘codifiability’ of tasks. The three main types for codifiability in this analysis are ‘trivial codifiability’, ‘complex codifiability’, and ‘no codifiability’. In addition, the authors use the extent of ‘coordination’ for the comprehensive description of tasks in order to monitor the production processes. To describe the extent of coordination, a distinction between ‘trivial coordination’ and ‘complex coordination’ is needed. A trivial coordination shows a higher degree of offshorability than a complex coordination. Figure 1 summarizes the characteristics in morphology. It serves the representation of attributes and the related levels.

Attribute	Attribute Level			
Blinder				
Customer Contact	Impersonal		Personal	
Production Property	Automation	Labour Presence	Customer Presence	Location Constraints
Levy/Murnane/Autor				
Type of Problem	Deductive	Inductive	Pure Pattern Recognition	
Task Skills	Routine		Nonroutine	
Type of Tasks	Manual	Cognitive	Interactive	Analytical
Learner/Storper				
Codifiability	Trivial Codifiability	Complex Codifiability		
Coordination	Trivial Coordination		Complex Coordination	

Fig. 1 Morphology of the characteristics of tasks

2 Offshorability Along the Value Chain

The current paper concentrates on the distribution of tasks along a value chain. Therefore, tasks for the production process must be taken into consideration in value-chain analysis. Firstly, the properties of the service offshoring are transferred onto value-added production tasks. Blinder mainly defines customer contact in terms of proximity to customers. The distance to the customer and the effort during transport are the main properties for estimating the customer contact. Thus, the resulting value at the customer is diminished by the transport costs. Therefore, in the following analytical methodology, 'transport requirements' are used as an attribute. These transportation requirements are taken into account for both the upstream and the downstream production stages. The downstream transport costs of a production step are equal to the upstream transport costs of its neighbouring production step, and vice versa. The sum of the upstream and downstream transport costs result in the total transport requirements. The categories for the transport requirements are 'low', 'medium', and 'high'. The transport requirements are also estimated by the necessity of product protection, the weight of the product, and the required holding devices. A lower transportation effort, for example, is needed in the case of beverage transport. Additional fixtures are not required; dimensions and weight of the crates are small. The transport of steel products, however, has a high average cost level due to the higher weight and larger dimensions. A high transport effort is assumed for really heavy products and for the transport of hazardous materials or liquids.

Blinder's physical presence and the location constraints deal with customer communication. This fact is also represented by the derived attribute levels: fully automated production lines require only little communication among the employees. Labour presence is the case with the interaction of workers. Customer presence means the communication between internal employees and external customers. A location constraint is characterized by an even higher need for communication at the plant. Thus, only the degree of communication needs is assessed in our analysis; the attribute 'communication requirements' is defined by the attribute levels 'high', 'medium', 'low', and 'not needed' in the morphology. The communication requirements relate to production stages, as well as to suppliers, customers, and intermediaries. "No need for communication" is usually the case if the production steps are completely independent or industry-specific, e.g. the raw material extraction activities. "Little communication" is almost always the case in adjacent production stages. A middle level of communication is required if multiple processes interact simultaneously. Communication is high if a strong interaction with customers exists or a transfer of goods with special, dangerous properties takes place.

In addition, for the evaluation methodology, the mentioned five property-couples of Levy and Murnane, Spitz-Oener and Autor are relevant. These combined attribute levels are used in the evaluation methodology in order of their descending offshorability levels. In sum, they establish the total 'task requirements' of value-added processes. The most difficult task determines the offshoring potential of the entire process. In general, routine tasks are equal to blue-collar skills; non-routine tasks are equal to white-collar skills. ‘Routine manual’ tasks are mainly physical without any decision or reflection needs, e.g. the assembly process within a series production, such as in the automotive industry. ‘Routine cognitive’ tasks require additional decision competencies, such as making a quality choice. ‘Non-routine interactive’ tasks are, for example, common in sales transactions. A lot of interaction with customers takes place, so automation cannot be realized. ‘Non-routine analytical’ tasks are primarily needed in the production of chemicals. They help to ensure a safe production and to dam the risk of leakage of any toxic substances. ‘Non-routine manual’ tasks contain an additional complexity, because physical skills and analytical abilities are required at the same time, e.g. the installation of an offshore wind facility.

Within the assessment methodology, the two different attributes of Leamer and Storper are grouped together with their unique levels in various combinations. This results in the attribute ‘codifiability’. The following combinations were taken into account: ‘trivial codifiability/trivial coordination’, ‘complex codifiability/trivial coordination’, ‘complex codifiability/complex coordination’, ‘no codifiability/complex coordination’. In the first case, routine tasks are combined with only little value creation, e.g. cleaning processes. In the second case, cognitive skills are needed to complete the required tasks. The created value remains low, and in- and output hardly differ from each other. In the third case, non-routine processes are described that are strongly connected to other processes. This is the case if tradable intermediates are produced during the production. The fourth case is characterized by extraordinary events, such as a highly complex production or the handling of hazardous materials.

Based on the transformed attributes proposed by different authors, an evaluation methodology for the analysis of the offshorability level of different tasks was developed. To analyse the final degree of offshorability of a unique task, it was examined individually with regard to its characteristics, and evaluated. It results in an overall value, which allows a statement about the degree of offshorability. The intervals of the clusters for assessing the offshorability are uniformly distributed according to the *fuzzy methodology*.[1] The offshoring potential ranges from high over middle to low down to a barely existing potential. “Traffic light” colours illustrate the offshoring potential visually. Figure 2 shows the final evaluation scheme.

3 Findings

The developed evaluation scheme was used on all tasks in the following seven industries: textile, timber, chemical, metal, electro-technology, and automotive industries as well as in mechanical engineering. In this approach, a production

[1] The fuzzy logic expects, according to the Gauss distribution, a symmetric distribution of individual attributes. On a scale from zero to one, the characteristics are equally distributed, and thus assessed in ascending order. The higher the value, the higher the offshorability of the task at such an attribute level.

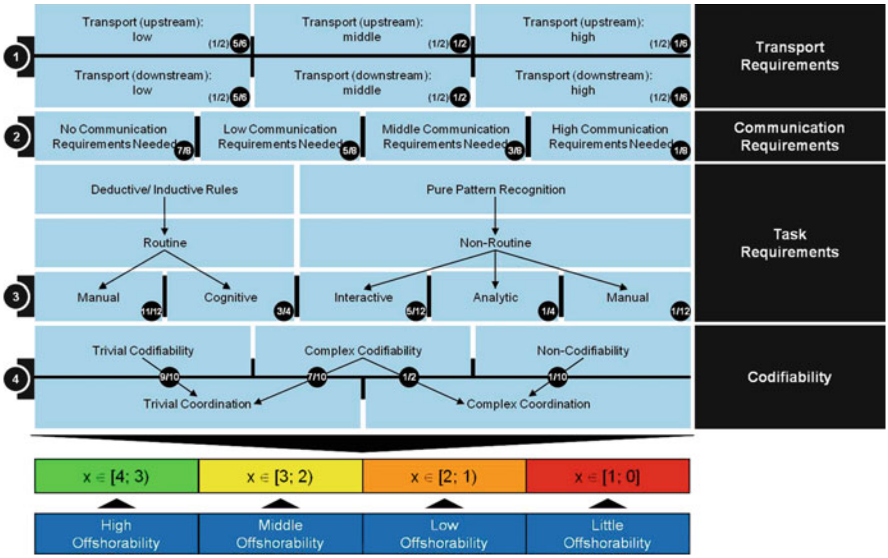

Fig. 2 Methodology for the analysis of the offshorability of tasks

step consists of many tasks. The offshorability of a single production step is estimated as the mean of the offshorability of tasks in this production step. Some steps are easier to offshore; others cannot be relocated without their neighbouring steps due to different technological restrictions. In the following, the offshoring properties of the textile industry are explained thoroughly; the other abovementioned industries follow the same methodology. The findings in those industries are summed up.

3.1 *The Textile Industry*

The first production stage in the textile manufacturing industry is that of **fibre extraction**. This industry receives most of its processing resources from other industries. Since there is no material input to be delivered, the upstream transport costs are considered to be low. Following fibre extraction, the product has already passed through its first production stage. The fibres could be damaged during transport, so the transport costs of the next stages are considered to be medium. During fibre extraction, there is no need for communication with other processes or with suppliers. The process is implemented independently of external influences. The work requirements are mainly manual and routine. However, owing to the different methods of extracting fibres and the relevant decision making capacity required for implementing these methods, the work is also seen as cognitive. The routine work tasks can be described in the form of simple directions and so their codifiability is trivial. Only the daily inputs and outputs need to be checked. All things considered, the offshorability of this production step must be classed as high.

During **fibre preparation** the fibres are washed and combed. The work tasks involved in this process serve the next direct step of spinning and twisting. Transport costs are considered to be medium because transport becomes more difficult owing to the improved quality of the product. The fibres are in bales and have to be further processed in this form. During fibre preparation, there is no need for communication, because this is a standard process. Owing to the straightforward tasks involved, the work is considered to be manual and routine. For this reason, its codifiability is trivial. The washing and combing tasks can easily be described in the form of simple rules. The coordination is also trivial, because the output practically matches the input. All in all, the offshorability of this production stage is high.

During the **manufacturing of textile yarn**, natural and man-made fibres are spun into yarn. Traditionally, this task was implemented by hand. During twisting, the strands of spun yarn are twisted into a thicker strand. Similarly to the previous stage, the transport costs for this particular process are considered to be medium. An intermediate product is produced, which needs to pass onto the next stage without any loss of quality. The need for communication is low. Decision making is required as to whether fibres should only be spun into yarn or whether they should be additionally twisted. These are manual routine work tasks which are automated. The processing method is dictated by the following step. The codifiability of the routine tasks is trivial. If concrete instructions are given, misunderstandings are not likely to occur, which means that supervision of this production stage is easy. The offshorability is medium.

Fabric manufacturing entails materials being made out of yarn or fibres. This stage is composed of weaving, knitting and yielding. The product is stable, so the downstream transport costs can be considered low. There is a slight need for communication with the yarn manufacture and textile finishing steps. The need for decision-making regarding the possibilities involved in manufacturing fabric mean that this is a routine cognitive task, so that its codifiability is complex. The coordination is trivial, because this process can easily be supervised. The offshorability resulting is medium.

In the **textile finishing** step, intrinsic properties of the textiles are changed. Processes involved here are dyeing and printing. The stability of the product – mentioned in respect of the previous step – remains unaltered – only the dyeing is varied. Thus, the downstream transport costs are considered low – like those for the previous step. The dyeing of the textiles has to be coordinated with the next stage – that of clothing manufacturing – so there is a slight need for communication. According to customer wishes, the resources involved in the colours and the prints vary. On account of the process-optimized utilization of printing facilities, cognitive decision-making is an integral part of this routine task. The great variety of colour designs and the necessity to set the machinery accordingly mean that codifiability and coordination are complex. In total, the offshorability of this stage is medium.

The **manufacturing of clothing** involves a saleable end product being manufactured out of a two-dimensional piece of fabric. At the end of this supply chain, the product is ready to be delivered. For delivery to wholesalers, a large number of the same products are required. This means, then, that transport costs are low despite the clothing having to be packaged. As the wholesalers order the goods, the need for communication is low during packaging and transporting. The work tasks involved are routine cognitive. The work can be clearly structured. With small manufacturers, however, additional process-optimizing decisions have to be made. Codifiability of this stage is trivial. With clear-cut instructions, the production process can be implemented in a structured way. Coordination is controlled by input–output data, and therefore trivial. All in all, the clothing manufacturing step within the textile industry is highly offshorable.

If the technological restrictions are taken into account, the production of the fibre and the textile yarns cannot be separated. All together they have a middle degree of offshorabilty. Figures 3 and 4 illustrate the offshorability in this industry with and without the process restrictions.

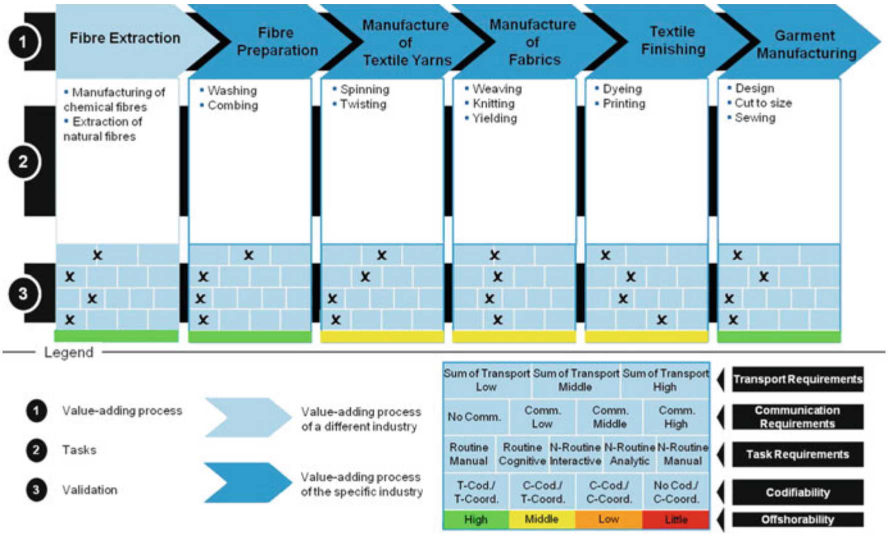

Fig. 3 Evaluation of the offshorability in the value chain of the textile industry. (The value chain on the basis of Schneider (2003).)

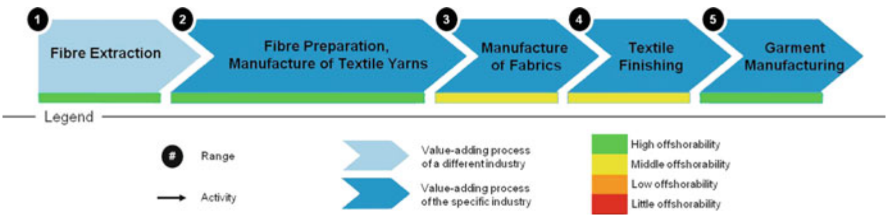

Fig. 4 Evaluation taking into account the technological restrictions of the textile industry

3.2 The Timber Industry

The timber industry uses wood as a raw material. This binds the first step of the value-added chain of the timber industry geographically to the **cultivation and harvest** location of the resource. After the harvest, the different types of wood have to be divided up into **different levels of quality**. At this point of the value chain, the less valuable wood is used to produce paper products and chipboards, whereas the higher quality timber is processed in timber mills to produce various kinds of timber products.

Before sawing machines cut the timber, it needs to be dried. Depending on the value of the timber and the product, the drying process is done by machines or simply by storing it for a longer time. The dried wood is then cut into beams and boards. The **cutting process** depends on the future purpose of the respective trunk, as well as on the characteristics of the material. Different textures and knots require a **further classification** of the wood before or during the cutting process. Some of the cut timber is directly delivered to the customers; the rest is processed in further production steps. A large part of it is used to **produce wooden plates**. A certain type of wooden plate is the "veneer plate", where a very thin slice of higher quality wood is glued onto a chipboard to create a high-class impression. In the last production step, the wooden beams and plates are adapted to the requirements of the **final customer** by applying different technical processes, such as sawing, polishing, drilling, and gluing. In the mass production section of the timber industry, the steps where physical work is applied to the material are at least partly automatable, which leads to an easier offshoring decision regarding these steps. The classification of the timber, on the other hand, is a complex visual analysing process that still cannot be done effectively by machine (Fig. 5).

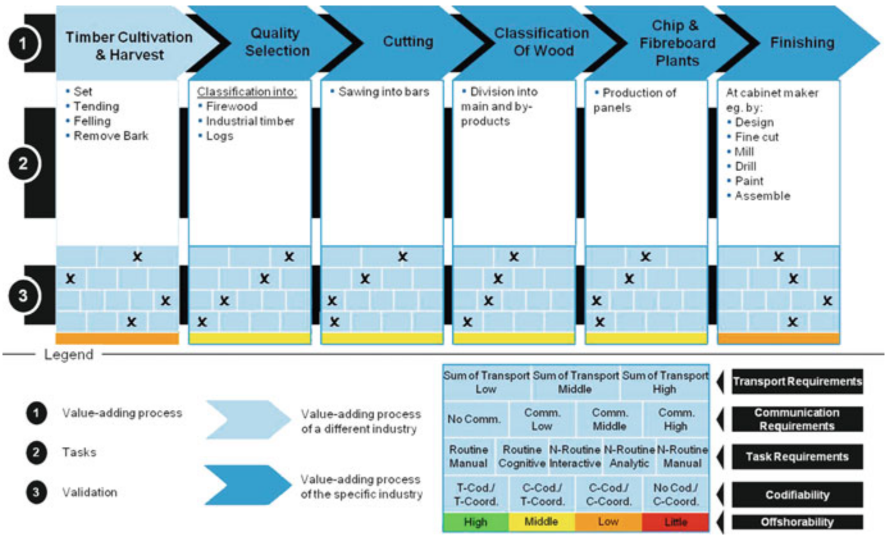

Fig. 5 Evaluation of the offshorability in the value chain of the timber industry. (The value chain on the basis of Holz Forum Allgäu e.V.)

Fig. 6 Evaluation taking into account the technological restrictions of the timber industry

The above developed evaluation scheme was used for the timber industry and the following results were drawn: The first production step in the timber industry - cultivation and harvest- shows a low degree of offshorability. Debarking, drying, chipping, and qualification of the wood are production steps which are not separated, due to production requirements, and they have a middle offshorability degree. The production of wooden plates and beams shows a middle degree of offshorability, whereas the last production step cannot be offshored easily due to customer restrictions (Figs. 6 and 7).

3.3 The Chemical Industry

This paper analyses the value chain of the chemical industry by using the exemplary value-added chain of the production of plastics. The production process of plastic begins with the **exploitation of petroleum**. This step is geographically bound to the location of the raw material, so that it cannot be easily relocated. The next production step is the **refining** of the crude oil, which separates the oil into different components, such as benzine, diesel, naphtha, tar, and bitumen. The naphtha fractions are very important as primary material in the chemical industry. In the **cracking process**, the long-chain hydrocarbons are split up into shorter hydrocarbon chains, which include ethylene, propylene, acetylene, and benzene. By **mixing** these primary materials with additives, such as catalysts, stabilizers, and plasticizers during the process of **synthesis**, different plastics with specific characteristics are produced. The last production step of the value chain is the **filling and packaging** of the produced plastics.

The evaluation of the chemical industry is illustrated in Fig. 7. The different production steps in the chemical industry cannot be offshored individually. From a technical and economical point of view, it makes sense to group the first two and the last three steps together. The chemical industry is essentially based on only two process combinations. The first two production steps, raw material production and refining, show a low degree of offshorability. Cracking, mixing, synthesis, filling, and packaging also have, all together, a low offshorability level (Fig. 8).

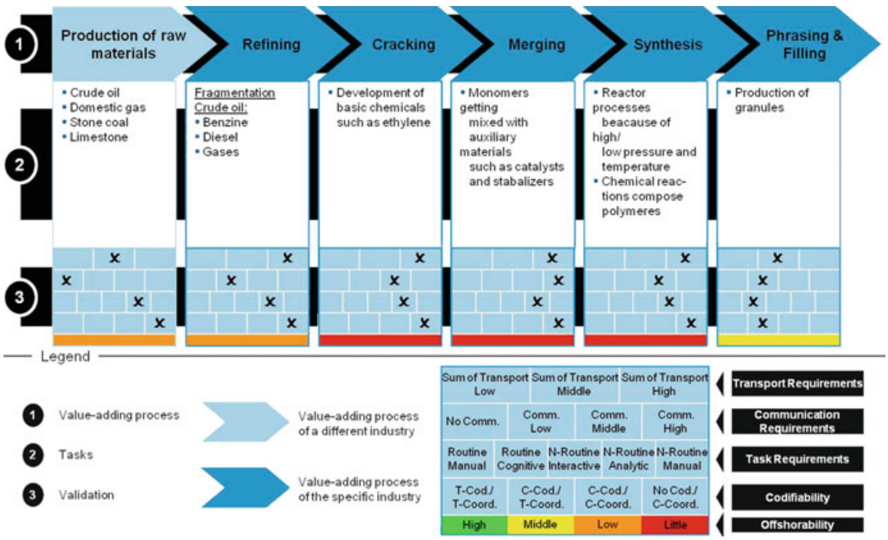

Fig. 7 Evaluation of the offshorability in the value chain of the chemical industry. (The value chain follows the basis of Michaeli (2004).)

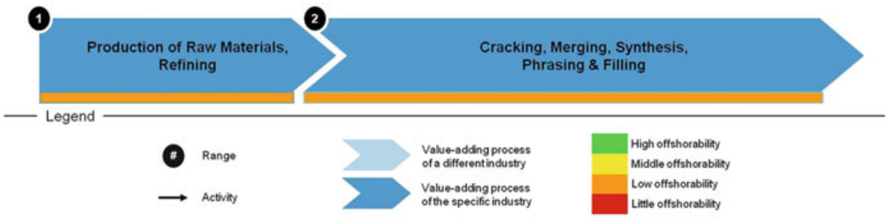

Fig. 8 Evaluation taking into account the technological restrictions of the chemical industry

3.4 *The Metal Industry*

In the current paper, the metal industry is analysed on the production process of steel (Fig. 9). The first production step in the steel industry belongs to another industry. **Raw material mining** is undertaken by a mining company which mostly continues with the next production step. At the **ore dressing stage**, mechanical processes are implemented in order to remove as much ore as possible from the rock. The fine grains enable flexible storage methods and facilitate transport, but as a mass they can be very heavy. For the further processing of ores, big machinery is needed, which has a high degree of automatization.

Iron making is the first production step in the actual production of metal. In order to produce pig iron, ores have to be mixed with coal and coke in a blast furnace at high temperatures. The liquid iron smelt is not transportable. The adding of alloys is done in

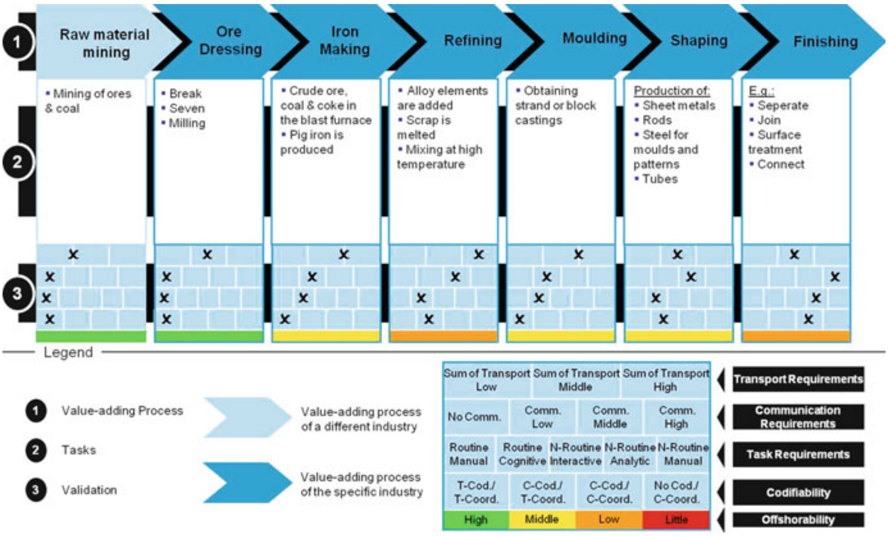

Fig. 9 Evaluation of the offshorability in the value chain of the steel industry. (The value chain on the basis of Wecobis (2011).)

the **refining** step. The liquid iron is poured out of the blast furnace into a vessel and the corresponding alloy elements are added. As with the iron making process, the intermediate product passes on to the next process as smelt. There is, then, no possibility of transporting. At this stage, the work is physically very demanding. Know-how for assessing the smelt samples is not easily automated. Following the refining, **moulding** takes place. Customer orders and the "pull" mechanisms of the following processes require only a small amount of communication for coordinating the casting forms.

During **shaping**, sheets, rods and other forms are produced out of large metal blocks. They are further processed later on in the **finishing process**. The small dimensions and the resulting low weight result in their being easily transportable in comparison to the further production steps.

The different production steps in the steel industry cannot be offshored individually. From a technical and economical point of view, it makes sense to group the first two 'mining' and 'ore dressing' and the next three steps 'iron making', 'refining' as well as 'moulding' together. This combination changes their offshorability level slightly (Fig. 10).

3.5 *The Electro-Technology Industry*

The electrical industry is a very heterogenic sector, which produces both investment goods and consumer goods. Especially the household electronics sector is influenced

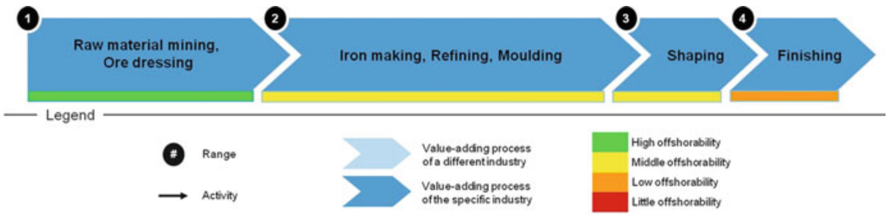

Fig. 10 Evaluation taking into account the technological restrictions of the steel industry

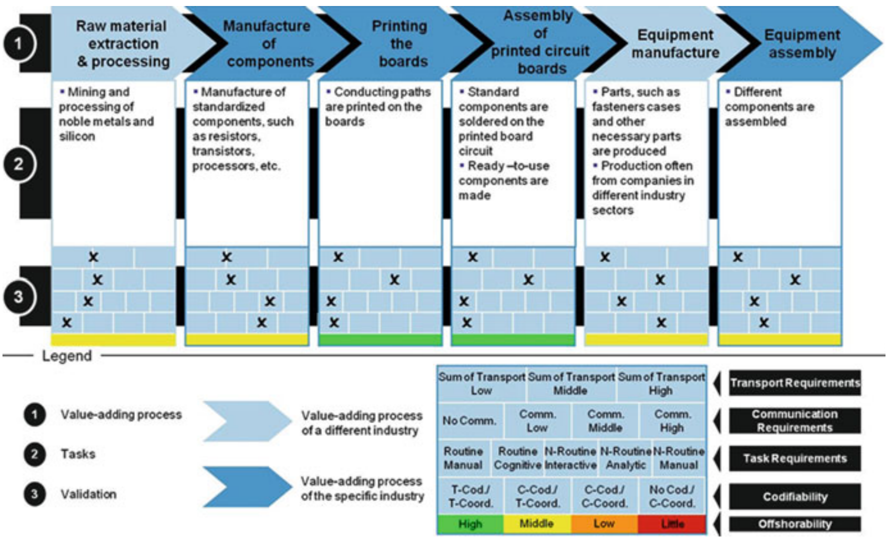

Fig. 11 Evaluation of the offshorability in the value chain of the electro-technology industry. (The value chain on the basis of Independent Research and Advisory (2005).)

by offshoring. Therefore, the value-added chain of the household electronics industry will be analysed in the following (Fig. 11).

The value chain begins with the **production and refinement of raw materials**. In the next step, electronic **components are manufactured** from the various primary materials, such as noble metals and numerous minerals. These basic components are produced in extremely large quantities in automatic processes. In the next production step, **circuit boards are produced**. In the household electronics industry, the products are produced in great numbers. This makes the fully automated production of the circuit boards economically efficient. In the next step, the circuit boards are **equipped** with the basic components. This can either be done manually or fully automatically depending on the quantity. The **production of the apparatus**, which includes tasks that do not belong to the electrical industry, such as plastic housings and switches, can be done parallel to the other production steps. In the final step, all components which have been produced in the prior steps are **assembled**.

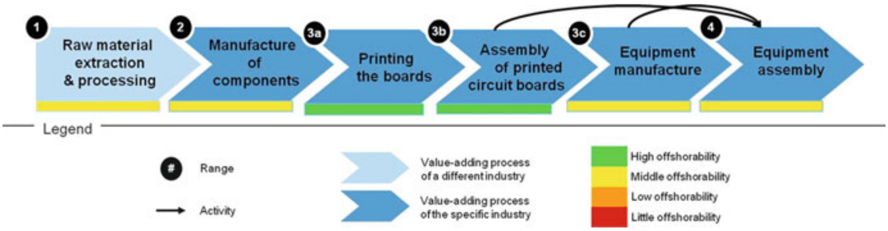

Fig. 12 Evaluation taking into account the technological restrictions of the electro-technology industry

The first two production steps in this value-added chain show a middle level of offshorability and can be undertaken individually. The following two -production and equipment of circuit boards- can be done individually as well and have a high offshorability level. These two steps are often done in East Asia. The production of the final apparatus and the assembly are also two separate steps with a middle offshoring potential (Fig. 12).

3.6 Automotive Industry

In order to reduce the complexity of this value chain, the current paper focuses on the value chain of an Original Equipment Manufacturer (OEM), which can be divided up into four sections that can be performed separately. An OEM purchases cast parts from a **foundry** at the beginning of its production process. The following step is the **pressing plant**. The metal coils arrive from suppliers and are processed into body parts of the automobile, using different processes, such as pressing and cutting. In the **body construction**, the metal sheets from the pressing plant are combined to form the body of the car. In modern production lines, this step is done by welding robots to increase quality and to reduce lead times. The finished bodies are transported to the **paint shop**, where the entire body is first painted in a sequence of different painting processes. The body work and the paint shop are technologically bonded to each other. In the **preassembly** supplied components are assembled into modules that can be directly integrated into the final product afterwards. This production step is often outsourced to external suppliers. For instance the production of the motor consists of the production of components and the assembly of the motor, where parts from a company‘s own production facilities and from suppliers are combined to form the motor. The last production step of the automotive industry is the **final assembly**, where all components and modules of earlier production stages are combined to become the finished car (Fig. 13).

All of the production steps in the automotive industry show a middle offshorability degree, but they cannot be relocated individually. Body construction and paint are performed together, and the production of the motor -the preassembly- and final assembly cannot be separated from each other (Fig. 14).

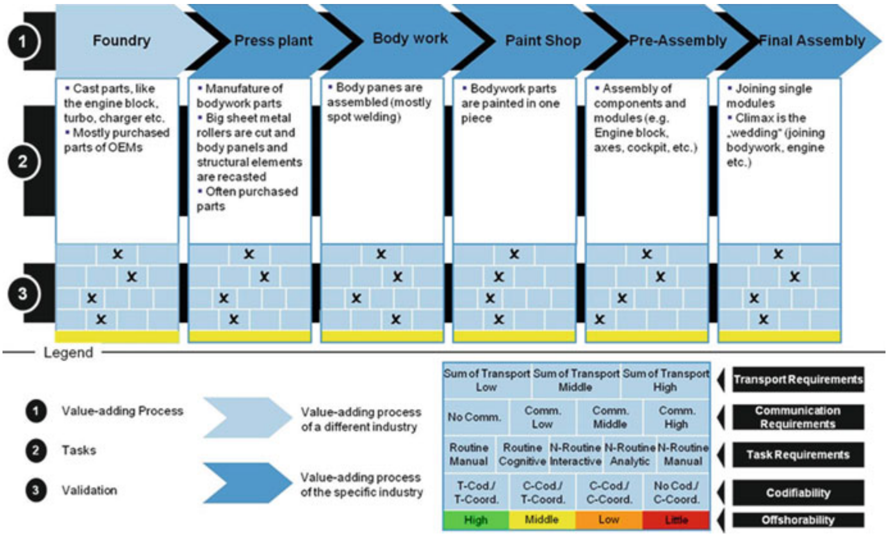

Fig. 13 Evaluation of the offshorability in the value chain of an OEM. (The value chain on the basis of Marktl (2010).)

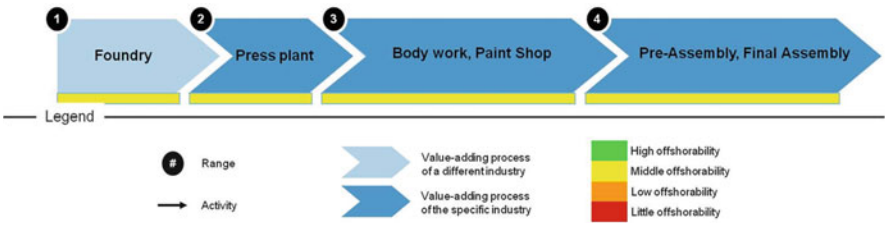

Fig. 14 Evaluation taking into account the technological restrictions of the OEM's production

3.7 Mechanical Engineering

The high product variety of the machinery and plant construction, which reaches from enormous and complex plants down to small machines, makes it impossible to identify a value chain that reflects the structure of the entire industry. Nevertheless, this paper provides a basic understanding of the offshoring potential in the machinery and plant construction industry by analysing the production steps of the wind turbine industry, whose high complexity and innovation intensity are taken as representative of the complete industry (Fig. 15).

The value chain in wind turbine industry begins with the **production of complex materials**, which are needed in the following production steps. Parallel to this, **preassembled modules** are manufactured. This step is performed by external suppliers, whose activities can often be assigned to other industries. To be able to transport the **shell of the wind turbine**, it has to be produced in various segments. Especially the large tower cannot be transported in one piece. In the production step **component production**, the individual parts and modules from different suppliers are combined into independent modules with components from the company's own production. In the **preassembly**, the wind turbine is assembled as far as possible, while still allowing the transportation of the wind turbine to its destined location. The **final assembly** and the start-up procedure take place at the ultimate destination of the turbine.

Compared to the industries above, in mechanical engineering all production steps can be done separately. The value-added steps "preassembled modules" and "component production" show a middle degree of offshorabilty, whereas production of complex materials, body shell work and preassembly have a lower offshoring potential. The last production step, "final assembly", cannot be offshored at all (Fig. 16).

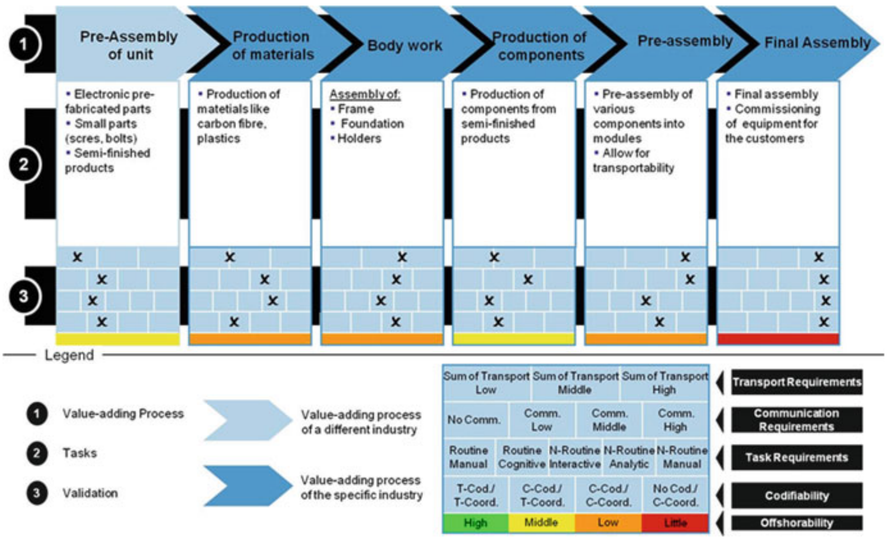

Fig. 15 Evaluation of the offshorability in the value chain of the wind turbine industry. (The value chain on the basis of Germanwind (2010).)

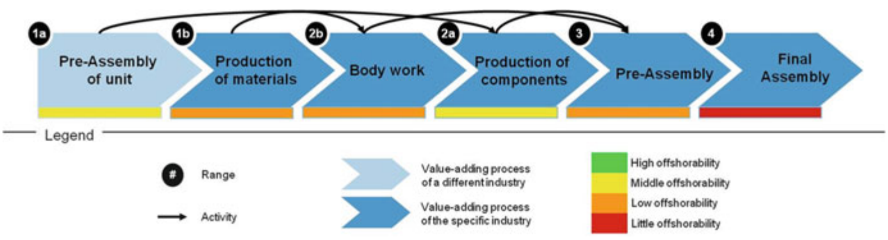

Fig. 16 Evaluation taking into account the technological restrictions of the wind turbine industry

4 Conclusions

Rapid advances in information and communication technologies have led to a sharp increase of the offshoring activities of various companies. Theoretical approaches are mainly based on the offshoring costs of each production step. In contrast, this paper deals with the production chain as a whole, and analyses the different tasks of each production step within the technological restrictions of exemplary value chains.

Based on the works of Blinder, Levy and Murnane, Autor and Spitz-Oener, and Leamer and Storper, four different groups of properties were defined: the 'transport requirements', the 'communication requirements', the 'task requirements', and the 'codifiability'. Out of these four groups of properties, the evaluation methodology was developed to analyse the offshorability of tasks. This methodology was applied to the exemplary value chains in different industries. Afterwards, the technical restrictions of the value-adding processes were reviewed.

In summary, an increasing offshoring potential was recognized. The results of this paper show that some value chains have a pronounced tendency to undertake more offshoring activities, especially the textile, automotive, and the electro-technology industries. In contrast to these industries, the timber and chemical industries show a generally lower degree of offshorability. It must be noted, however, that in the current paper, the consideration of offshoring costs is not included. The combination of monetary aspects and the qualitative results of this paper can provide a more general evaluation of offshoring activities. For the next logical step, it is planned to match these findings with empirical results from the production chains of more than 200 German firms. Information about these value chains was gained from an industry survey.

Acknowledgments The findings illustrated in this paper are result of the research project "Integrative Production Technology for High-Wage Countries". The depicted research has been funded by "Interdisciplinary Management Practice" (IMP) of RWTH Aachen University. I am deeply grateful to Christopher Weckbecker and Maximilian Kienböck for their contribution.

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Part VIII

Real World Implementations

Chairs:

Richard J. Schonberger
Tülin Aktin
Martin Gooch

Modelling Transformations in a Complete Fresh Food Value Network

Per Engelseth

Abstract Since the emergence of SCM as a field and profession within business management limited progress has been associated with modelling the supply chain. This study is associated with modelling a complete seafood product network founded on Alderson's transvection marketing channels model from 1965; from "sea-to-retailer" through multiple tiers of decision-makers to the value-evaluating end-user. Value generation through a network of business actors is modelled in balance with value realisation based on Alderson's approach. Product information is the unit of analysis in a case study of a retail-packed seafood product. In the study data was acquired through tracing the product flow from its finished state in retail to trawlers fishing in the Barents Sea. The case narrative, however, describes the information flow based on interaction with the product flow including descriptions of packaging and goods identifications. Transformations of products in interaction with information are modelled through the scope of a complete value generating supply network. This modelling represents a "bottom-up" technical approach. Features of boundary-spanning through multiple tiers in a supply network are modelled in the context of decision-making actors and the product flow. Three models depicting interactions in a supply network as interaction between (1) product transformations, (2) information transformation and (3) knowledge transformation are generated by empirical findings and applied to analyse fresh seafood supply. This modelling provides basis for developing supply network integration in fresh food supply.

Keywords Complete seafood supply networks • Information • Modelling • Network integration • Transformation • Transvection

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, 373
DOI 10.1007/978-3-7908-2747-7_19,

1 Introduction

Despite attention to and wide use of the "supply chain management" (SCM) term in academia and business, supply chain performance has yet to live up to the expectations that were created when first coined in the early 1980s. Since the emergence of SCM as a field and profession within business management (Oliver and Weber 1992, Lambert et al. 1998, Giunipero et al. 2008) limited progress has been associated with modelling the artefact that is to be managed; "the supply chain." Lambert et al. (2000) state that: "There is a need for building theory and developing normative tools and methods for successful SCM practice." A key aspect of product supply is associated with value generation to match supply chain end-user requirements. Porter's (1985) value chain model is influential in understanding factors and interdependencies related to efficient and customer-oriented product supply. The supply chain may be understood in accordance with this model as a value chain. In this study SCM is understood as a wide area of research and business practice encompassing a diverse spectre of more specific practices and research approaches including value chain management (VCM). This paper is associated with a VCM quest for generating value though *modelling*. Value generation is proposed modelled in multi-tier complete fresh food business *networks* placing focus on *information,* the resource or "glue" that binds actors with product transformations. This represents an alternative to the commonplace actor-focus in SCM literature. Since the quality value generation in physical distribution is associated with measuring product supply characteristics, it is product information that is chosen as the unit of analysis in this study. This network approach is placed in an interface between several established fields of research; predominately industrial marketing, SCM, and logistics. A case narrative describing the flow of a packed seafood product retailed in Oslo Norway was in the case study, following Alderson's (1965) transvection approach, traced back to its origins on trawlers fishing in the Barents Sea outside Hammerfest in Northern Norway. The applied approach involves modelling transformations from this seafood product's origin to its final fresh state ready for use in a retail setting. The case narrative and methodological considerations provide empirically-basis for following analysis involving discussion towards modelling complete supply chains or networks. A set of models attempt opt simplify how value realisation in the scope of a complete supply network involves layers of transformation that demand intra-and inter-firm aspects of integration.

2 Particularities of "End-to-End" Complete Food Supply

Given that the provided empirical evidence concerns a seafood product, the first step is to create focus by discussing particularities of food supply and which consequences these particularities have on modelling this form of product supply.

Lamming et al. (2000) point to the importance of discerning industry-specific product features (or particularities) regarding managing supply networks when discussing elements in “an initial classification of a supply network.” Furthermore, Fisher (1997) and Christopher et al. (2006, 2009) point to the lack of adopting SCM models to variations in products and market types as an important source of SCM failure. According to Lapide (2006) customer-responsive product supply demands context specific solutions crafted based on a strategic framework. One important feature of food supply is the need to model a complete supply chain based on seasonality, perishability, safety and traceability factors (Van der Vorst et al. 2002, Taylor et al. 2006). Intermediary trading organisations in food industry face challenges in coordinating retail promotions with lead time requirements and in general low degree of complete supply chain flexibility and supply requirements (Adebanjo 2009). Bijman et al. (2006) point out that increased inter-organisational collaboration in food supply is due to (1) the rise of food safety as prominent societal issue, (2) the raw material in food distribution often closely resembles the finished product, and that (3) foods are to varying degrees always perishable goods. Fresh foods, such as the studied fresh packed seafood, are perishable products. This limits the time frame of their transformation during supply. Fresh food distribution specifically involves challenges including that “. . .(1) fresh products are not standard and subject to quality deterioration, (2) there is a lack of clear product descriptions and coding standardisation, (3) information requirements differ per customer, making standardisation complex, and (4) a relatively low degree of automation of farmers” (Van der Vorst et al. 2002).

An important aspect of food supply is ethically-related since food consumption is a vital aspect of human well-being. Food supply chains seek accordingly to balance food *safety*, a societal aim, with *economic* and *quality* product supply, representing business aims (Engelseth et al. 2009). “Safety” in food supply denotes food product features measurable through the supply chain in relation to human well-being dependent on technicalities of food supply, whilst “quality” involves product attributes measured in relation to customer satisfaction (Van Rijswik et al. 2008). According to Becker (2000), food product quality involves (1) product-oriented quality, (2) process-oriented quality, and (3) consumer-oriented quality. These are all aspects that need to be matched with different dedicated control mechanisms.

Regarding the information flow involved in food supply, Lindgreen et al. (2003) investigated the need for transparency and tangible communications in food chains to improve the provision of product information to end-users and business actors. In addition Folinas et al. (2006) pointed out that features of intra-organizational information processing/communication and inter-organizational communication have an effect on product information. Information systems play an important role also in facilitating the more daily food control activities including HACCP (hazard analysis and critical control point: http://vm.cfsan.fda.gov). Product safety requirements are intertwined with *food traceability* requirements. The ISO 8402:1994 standards define “traceability” as “. . .the ability to trace the history, application, or location of an entity by means of recorded information.” The tracing of food products involves retrieving product information that was previously registered by actors who are responsible for certain steps in the product supply chain. Achieving food product traceability is accordingly interlinked with achieving transparency in product supply. Folinas et al. (2006) state that the minimum information requirements for a product traceability system are product lot number, product ID, product description, supplier ID, quantity measures, unit of measure (e.g. "kilo"), and buyer ID. Securing product traceability is according to Engelseth (2009) dependent on the collective effort and competence of supply chain actors. Given the societal importance of safe product supply coupled with customer demands of product traceability in food industry, information connectivity must be secured between different actors to secure the technicality involved in providing this type of product information.

3 SCM and the Supply Network as Research Object

The notion to manage a complete supply chain from "end-to-end" dates back to Forrester's (1961) seminal work. Already in the late 1950s Forrester envisioned modelling a complete supply chain when writing that: "Management is on the verge of a major breakthrough in understanding how industrial company success depends on interaction between flows of information, money, manpower, and capital equipment." While definitions of SCM espouse the benefits end-to-end product supply management (e.g. Lambert et al. 1998), SCM practice is limited to management of immediate to the firm, dyadic business relationships looking to procurement on one side and marketing on the other side (Van Hoek et al. 2006); SCM playing a role from a company perspective as an "arc of integration" (Frohlich 2002) or "pockets of good practice" (Storey et al. 2006). This firm-oriented perspective of "SCM" coincides with Christopher's (2005, p.5) SCM definition as: "The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole." This definition of SCM may be viewed in an alternative light through the possible more widely disseminated SCM definition by Cooper et al. (1997): "The integration of business processes from end-user though original suppliers that provide products, services and information that add value for customers." While Christopher's definition perceives SCM from the perspective of a "focal" firm, Cooper et al.'s definition takes a more complete end-to-end view of SCM. This conceptual variety regarding SCM impacts to some degree on business practice (Hill 1989, Lapide 2006). This rich flora of SCM understandings may also be viewed as complementary since SCM involves firms developing competence in managing both the *complete* supply chain as well as from a *firm-perspective,* managing product supply coordinated with sales in an immediate business context. Furthermore, as Christopher (1998) points to and Håkansson et al. (2004) provide empirical evidence regarding, individual supply chains interact and compete with other supply chains. This calls for a network picture of product supply. Christopher's (1998) SCM view includes this perspective, stating that supply chains involve a network of organizations.

This represents accordingly the wide and complex context of “information supply” using information systems in a wider “supply network” interconnecting heterogeneous product flows in supply chains.

4 Modelling End-to-End Product Supply

Based on Forrester’s (1958) statement provided above, a picture of SCM emerges as competence in interaction with technical processes; the flows. Human understanding must in some manner be coupled with the actual value-creating process involving transformations of products, services or information. In this view modelling can play an important support for management and operations, including interlinking these levels of behaviour. Models are abstractions of reality, conceptual simplifications that interlink business practice with competence. Within SCM Lambert et al. (2000) propose a research agenda towards mapping the supply chain entity. They list a set of “physical and technical management components” and “managerial and behavioural management components” generating a complex conglomerate of factors used to model a complete supply “chain” or “network”. Modelling the supply network involves taking into account multiple mental models or “pictures” (Miller et al. 2001), to create a knowledge basis for product supply development (Petrie 1992, Andersen 2000 Vernadat 1996, 2004). Lockamy et al. (2004) provide a model that provides a classification and description of interdependence between supplier and customer relationships, and how these relationships may be subject to different degrees of integration. Skilton et al. (2009) model interrelationship between traceability (intrinsically involving the complete chain), transparency, supply network degree of tight coupling and supply network complexity. These models, however, do not depict in further detail how to in practice develop integration of internal, purchasing and sales processes to develop product supply efficiencies. Choi et al. (2009) propose modelling supply networks from involving three alternative perspectives: (1) focusing on the visible portion, (2) focusing on the invisible portion, and (3) focusing on the interface between the visible and invisible portions. Focus on information use in food product supply chains involves in practice a focus on interaction between the invisible and visible part of the supply chain. Following Choi et al. (2009), this provides guidance regarding the use of future models in relation to managerial decision-making regarding what may be controlled, and what cannot be controlled.

SCM definitions, such as the one by Cooper et al. (1997), include the flow of information as supporting product supply; the information flow playing a secondary role. Since modelling is discernable from actual business practice it is not required to start with modelling products or actor perceptions, the more focal supply network entities. Instead, it is here proposed to start by modelling the information flow, the entity in the supply network that binds divergent actors with value-creation through product transformation. The importance of boundary-spanning through IT is substantiated by Yao et al. (2009) revealing performance improvement measured by order cost reduction, inventory reduction and customer satisfaction. Information is the resource that may be measured in relation to quality as a flow entity, spanning firm boundaries through communication about products. The information flow is a complex entity associated both with (1) instances of processes and (2) the aggregate process level; across multiple instances or execution of a process. Product information reflects to varying degrees features of physical products and it is an entity discernable from physical products; one embedded in the information flow, the other in the product (or materials) flow. Kirikova (2000) describes how modelling an enterprise involves systems thinking, taking into account different components and their relationships work together in the enterprise as a whole. Here we expand this view to encompass linkages between different enterprises functioning together in a common supply network with borderlines defined by distribution patterns of a specific product. According to Christensen et al. (1999) information technology (IT) may be viewed as more than a field within the realm of technology. The value of IT, lays therefore not solely in technology, but in its strategic and purposeful use.

A product or service is created through a sequence of utility-providing activities measured from the perspective of an end-user (Alderson 1965, Thompson 1967). Lambert et al. (2000) point to the early contributions of Alderson (1965) and Bucklin (1966), how these marketing channels scholars "...conceptualized the key factors for why and how channels are created and structures. From a supply chain standpoint, these researchers were on the right track in the areas of (1) identifying who should be the member of the marketing channel, (2) describing the need for channel coordination, and (3) drawing actual marketing channels." Alderson (1965) pictures product supply as a complete end-to-end flow of products; a piecemeal process where product *transformations* are directed by intermittent decision-making events (termed *sorts*). The essence of Alderson's transvection model of a complete marketing channel involves a researcher following the flow upstream from the finished product placement in the "hands of the end user" to upstream "conglomerate resources" facilitating describing the operational downstream value-creating flow.

According to Hammer (1990) it is vital to understand the difference between the parts and the whole in this supply system: "Order fulfilment is comprised of a great many tasks: receiving the order from the customer, entering it into the computer, checking the customer's credit, scheduling production, allocating inventory, selecting a shipping method, picking and packing goods, loading and sending them on their way." Data is registered stepwise through the flow of products creating information about product quantities, dates, locations etc. Stepwise product information is transformed and thereby updated in relation to time, place and form features based on goods identification. Product-related data is also found in documents created or modified in relation to different steps of the product flow; local and event-specific information used by personnel assigning goods. In addition a customer orders and plans direct the product flow. As products are transformed in a supply network product information is also transformed to reflect the completion of these steps representing the basis for product traceability. Finally documents may be generated through the information system (IS) for controlling and managing

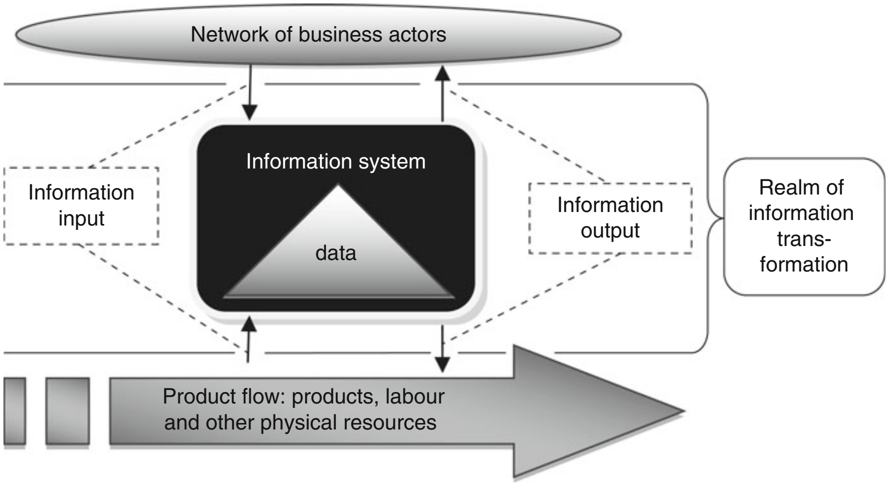

Fig. 1 Information transformation and information systems

product supply both from an operational and strategic viewpoint. Information transformation in an IS is contingent from a daily perspective in the supply network of: (1) external inputs consisting of updates based on product transformations and updates based on sales creating orders, and (2) the need to create adapted outputs in the form of documents and reports to control and secure operations and managing the product flow. This model of information transformation, provided in Fig. 1, needs now to be integrated into a complete supply network model.

Slack et al. (2008: 8) point to four different forms of operations strategy: (1) top-down, (2) bottom-up, (3) market requirements and (4) operations resources. This modelling effort is founded on the following operational-level case narrative describing the end-to-end flow of a fresh packaged seafood product involving, accordingly, a predominately "bottom-up," a technical approach. In the context of the operations our unit of analysis is "product information." The features of this boundary-spanning through multiple tiers in a supply network is modelled in the context of decision-making actors and the product flow. Managerial concerns play given this approach a contextual role in relation to product information in this network viewed as a logistical system. The next step is to provide a complete supply network case narrative to further develop modelling specifically a complete fresh seafood supply network from wild catch to retail.

5 Method

Case study research strategy was applied in accordance with Yin's (2008) view as a means to create focus and order in a complex supply network research setting consisting of series of mainly complementary seafood product transforming activities at a series of different facilities. Eisenhardt's approach (1989) was used to shape the case study research strategy aiming at creating an empirical foundation for future simulating this part of fresh seafood supply and at creating a case narrative that could be used to interpret the studied product with focus on responsiveness to customer needs ("market orientation").

The empirical foundation of this study is a case study of fresh food products in a complete supply chains (Engelseth 2007). From this study, packed fresh white fish supplied from an outsourced production facility in Northern Norway to retailers predominately in the more populous Southern Norway has been chosen. The case narrative provided here is accordingly a rewriting of the original case narrative in an adapted format. Data in the original study was collected using a semi-structured interview technique by listing the topics rather than questions for each interview. 63 interviews were conducted with members of four different product supply networks. The studied seafood chain accounts for one of these cases. Therefore approximately 40 of the interviews are relevant to constructing the provided case narrative which was structured in accordance with the provided framework of this study. This involves in practice a rewriting of an existing case narrative (Engelseth 2007).

Both interviews and observations were open, meaning that the true intention of the case study was communicated to the informants and persons observed. This openness was also used as a tool to ensure credibility of the research as discussed later in this chapter. All interviews were taped and transcribed. An interview lasted on average 1 h, with the longest interview lasting almost 4 h, and the shortest 15 min. Interviews were followed up by telephone interviews to clarify data and update information. Clarification of data also involved discussing potentially different interpretations of interview transcripts. The quest of the applied research strategy was accordingly following the research protocol aimed at gaining new insights. Data collection was directed by an emergent frame of reference written down and successively refined. The research protocol directed the formulation of interview guides, each adapted to a specific informant, and taking into consideration preceding findings. This involved designing the research process leading to "...observations generated new questions on which further interviews could be based" and eventually "added new dimensions to the subject, which eventually resulted in a new view of the phenomenon itself" (Dubois et al. 2002).

6 The Case Narrative

6.1 The Product Flow

"Marian fish filets" is a recently developed fresh fish product. Marian products have a durability of 10 days from catching the fish on the trawler until the best-before date expires. Each product consists of 300 or 360 g of premium quality fish filets.

The raw material used in the production must never be more than 2 days old. The product consists of three varieties: (1) “Koketorsk” (Cod for cooking), (2) “Steketorsk” (Cod for frying), and (3) “Seifilet” (Filet of Saithe. Saithe is similar to Pollack, having white to greyish colour meat and is common in Northern European cuisines and used for frying or in casseroles). The oxygen content is removed to prolong durability of the product which must be stored at 4°C. Fjordland, the distributor, guarantees the retailers that they have 5 sales days before the best-before date expires. Fjordland is responsible for the Marian brand name and product development of Marian products. Fjordland, however, does not catch, produce, or physically distribute the products.

Marian is produced by Aker Seafoods Hammerfest and the fish used by the Aker Seafoods production facility is caught in the Barents Sea outside Hammerfest. The large fishing trawlers are at sea for 5–7 days and deliver catches on Mondays, Tuesdays or Wednesdays, and on Fridays. If the trawlers fish close to shore they are at sea for 5 days; if further away, they use 1 day to reach the fishing location and 1 day to return. Each vessel has a government-set production quota. Important raw-material quality indicators are gutting, discolouration due to bleeding, and freshness due to temperature control. The catch is stable from November to September. During the months of September and October, catches are lower due to natural causes. Fish species migrate, and during these periods, fewer fish are present in the areas where the fishing fleet of Aker Seafoods does its fishing. The Marian products represent the freshest and best quality class of the raw-material fish, being maximum 2 days old and coming from the finest pieces. In the case of cod, the Marian products take about 30% of the premium quality raw material.

The Marian products that are produced at Aker Seafoods Hammerfest are distributed directly to 22 TINE distribution centres who then distribute the products onwards to retailers. While production is in Northern Norway, the bulk of consumption is in the more densely populated Southern Norway. These are actually sales dairies that mainly produce milk and other dairy products. Nor-Cargo Thermo carries out transport from Aker Seafoods Hammerfest to the regional TINE distribution centers (dairies). One truck transports the Marian products together with other products to the Nor-Cargo Skårer facility where the goods are further distributed to the various TINE distribution centres. At these distribution centres, the Marian Products are handled together with other food products. The transformation of Marian fish filets and the various types of packaging used to contain and identify this product are shown in the Fig. 2 designed in accordance with the transvection (Alderson 1965). At sorts the identified product form is indicated as packaging or other goods containment facilities:

6.2 Raw Materials Supply Information

The supply of Marian products is managed using weekly forecasts made by Fjordland. The forecast is used by Fjordland to inform Aker Seafoods of expected

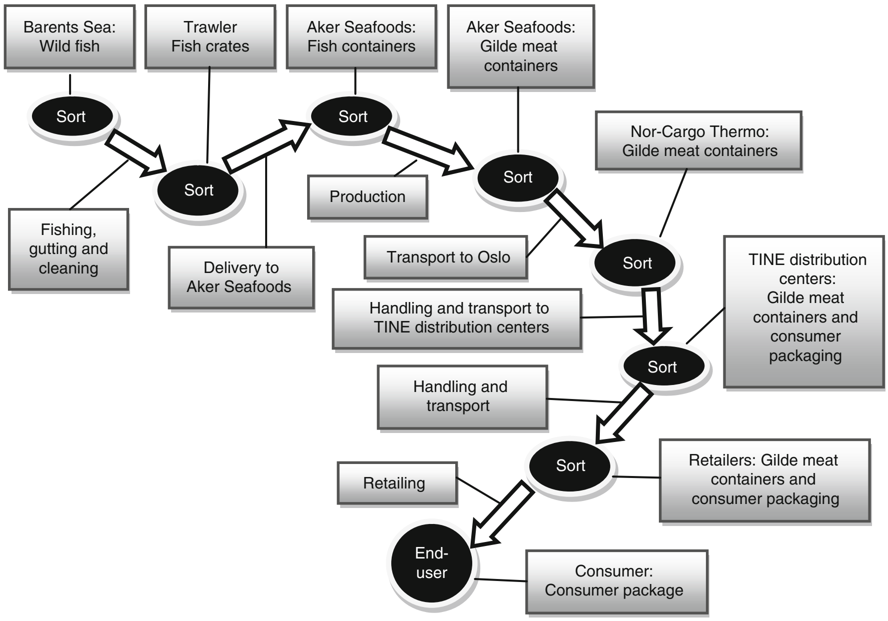

Fig. 2 The trawler-to-retailer seafood product flow

orders for the coming week. Aker Seafoods uses this information in its own production planning. In practice, however, the actual production volume of Marian products is based on orders, and the forecast from Fjordland therefore serves mainly a supporting role in relation to operations at Aker Seafoods Hammerfest. Supply of raw-material from the trawlers is based on an annual agreement negotiated between the Norwegian Government's fishery department and fishing vessel organisations. Fish quotas, together with the total anticipated demand for all of Aker Seafoods' products, are used to make a monthly production forecast for Aker Seafoods Hammerfest. This information is used in a Maritech production management system, a IS not interlinked with other ISs and used to manage, control, and register the production of fish at the Hammerfest production facility. The trawler carries a fishing log. This log is used to register the volume of the catch of each species, the location of the catch, and the time when the trawl containing the fish was hauled on board. The fishing log is a paper-based system and information is registered manually in a book. The trawler informs Aker Seafoods daily using mobile or satellite phone of the volume of the catch of each species and size. Upon arrival at Aker Seafoods Hammerfest facility, the fish crates are counted to get an overview of the volume and sizes of fish delivered of each species.

6.3 Order and Production Information

Retailers place orders in units of consumer packages containing Marian fish filet products of “Seifilet”, “Steketorsk”, or “Koketorsk”. When the Marian products arrive at the TINE dairies they are handled using a MOVEX ERP system, which creates all the documents and labels needed to deliver Marian fish filets to the retailers. The basis for these documents and labels are retailer orders. Aker Seafoods Hammerfest receives orders from each of the 22 TINE dairy distribution centres based on their accumulated retail orders. Forecasts for each of the Marian products provided by Fjordland to Aker Seafoods Hammefest is registered in an EXCEL data sheet and used to calculate the volume of production of each of the three Marian products. Furthermore, another EXCEL data sheet is used by Aker Seafoods to calculate the combination of its entire range of different goods produced on that certain day. This system is, however, not used to inform about the planned volumes of the different Marian products, which are thus produced based only on the received orders. The product-mix that is to be produced is then registered in the Maritech information system together with orders for Marian fish filet from the TINE dairies. This system then assigns different types of fish raw material to various modes of production and packing. The Maritech information system accordingly provides information regarding how much and what raw material has been used, how this raw material has been produced, and how much finished product have been packed in various kinds of packaging. The Maritech information system is also utilised to operate the production line that packs Marian products. This line also produces the labels on the consumer packages of Marian products. The Maritech information system is an isolated system and does not register order information from TINE distribution centre customers.

6.4 Information Concerning Transport and Handling

While the catching of raw material and the production of the Marian white fish products are located in Northern Norway, markets for these products are located mainly about 2000 km away, in the Southern part of Norway. Information about this long distance transport is therefore important in order to be able to supply customers. Aker Seafoods Hammerfest uses one of its EXCEL data sheets to register information regarding the orders of each Marian product to each of the TINE dairies. This EXCEL sheet calculates the number of Gilde meat containers needed and how many pallets of Gilde meat containers are to be sent to each TINE distribution centre. A paper copy of this EXCEL sheet is made and provided to the terminal workers handling the finished Marian products. Based on the EXCEL data sheet, transport labels are created manually using the data screen. The consumer packages are placed into labelled Gilde meat containers, and Gilde meat containers are placed onto labelled pallets in accordance with this information. At the same time, a transport document is created. This document is also sent to Fjordland in Oslo where this information, together with other transport information, is entered into TINE’s web-based information system. Nor-Cargo Thermo must access TINE’s web-page daily themselves to receive orders regarding transport services needed from them. Based on this information, Nor-Cargo Thermo in Hammerfest plans the loading and transport of its trailer from Hammerfest to Oslo. When Aker Seafoods reaches the end of the daily production of Marian products a call is made to Nor-Cargo Thermo's representative in Hammerfest requesting that a trailer come to pick up the goods at an agreed-upon time. When the goods have been loaded onto the truck the driver is handed a transport document that he/she signs and brings with the goods to the Nor-Cargo Thermo terminal at Skårer. When the goods arrive at the terminal facility, information provided from TINE's web- page regarding the distribution of its various products is used to handle the Marian products from Hammerfest, together with other TINE products. New transport documents are then provided for transport to different TINE dairies. The labelling on the distribution and transport packaging remains unchanged.

6.5 Supply and Retailing Information

Marian Fish Filets arrive at the retailer facility together with other products from the TINE distribution centre. The Marian products are then moved into the store display area. When Marian products are purchased, it is registered in the store computer system, and the need for stock replenishment is carried out manually in the same manner as for most other TINE products. Marian products are displayed with a label reading the name of the product and price on the shelf or inside a counter of the refrigerated area. If products are missing upon arrival at the TINE distribution centres the location of these goods will be tracked and this information then communicated to Fjordland, either by telephone or e-mail. Fjordland, in turn, will then telephone a query to Nor-Cargo Thermo asking where the goods are and when they may be expected. Nor-Cargo scans all its goods upon arrival and departure at the Skårer terminal, and therefore knows when the goods have been registered there. If the goods have not yet arrived, GPS and mobile phones may be used to locate the trailer carrying the product. If the trailer has experienced difficulties during transport from Hammerfest to Oslo, this will usually already have been reported and registered in the information system of the transport firm. The key account manager for the TINE account at Nor-Cargo Thermo then informs Fjordland about the location of the goods who again informs the TINE dairies.

6.6 Track and Trace

A limited amount of product information follows Marian fish filets downstream through the flow of goods. This information may be provided through documents and on labels carried by the packages at the same location as where the goods are located. This information is used to assign goods through logistics activities. If more detailed product information is needed, the person tracking the product will try to obtain this through the actors in the supply chain thought to be able to provide it.

Since Marian fish filets are new products there is no practice regarding how it is traced. Tracing may be done by locating and communicating to actors upstream in the supply chain until the necessary information is provided. Tracing Marian fish filets is then facilitated by telephone. This involves locating the actor who has the necessary information asking him or her to document the necessary product characteristics. This is because information regarding the flow of Marian fish filets is registered in different information systems that do not automatically communicate with each other. At the TINE dairies, information regarding the transport and handling of Marian Fish filets may be accounted for using the MOVEX ERP system. The state of Marian fish filets is registered here upon arrival at the distribution centres and registered as delivered at the retailer facility. The main type of information provided by the system is the time and location variables of the goods when operated by the TINE dairies. Information regarding the goods' temperature must be sought manually by accessing containment (transport, terminal and storage) facility temperature logs. Nor-Cargo Thermo may provide information from their information system by accessing temperature logs of the truck storage compartments and the time used for transport. The trucks carry a GPS system allowing for on-line control and adjustment of the storage temperature in the trailers' up to four different compartments. However, this information is registered only on board in the truck log. This logged information is stored apart from Nor-Cargo Thermo's information system and must therefore be manually accessed upon request. Information regarding loading and unloading and transit handling information from the Skårer terminal is stored in the information system based on registration when the bar-coded labels on packaging are scanned. It is now possible to trace the fish back to its state as a raw material in the fish tub prior to being placed into production, by using the Maritech information system. In addition, this system accounts for how the fish has been transformed during production, the persons involved in this process, and the time used. The consumer package label contains information regarding the country of origin and the lot number. This lot number is used by Aker Seafoods Hammerfest to first determine the trawler that caught the fish. It may then be compared with the trawler log and based on the information on the catches of fish registered, the area, and date where the fish used in the specific product was caught. Aker Seafoods had one incident last year in which another of its products, due to a product discrepancy, was traced to their facility. The detection of this mistake involved also tracking other goods produced from the same batch, and having these products disposed of. This incident is comparable to what potentially could happen if a retailer was to discover a problem with the quality of Marian fish filets.

7 Layers of Transformation in Complete Fresh Food Supply

The Marian seafood product supply case exhibits a complex conglomerate of business actors from the trawlers to retailers; a collective aiming to provide end users with safe and quality products in an economically feasible way through managing the flow of products from raw material at sea to finished packed product in display at a store. Given the ethically laden nature of food products due to quality and safety concerns, this underpins the importance of SCM in supporting not only economic supply, but also in line with Engelseth et al. (2009), coordination to secure end-user well-being. The structure of the supply network is based on this understanding of overall supply purpose combined with a flows view of its technical functioning (Alderson 1965), proposed modelled from a complete "end-to-end" perspective as an organisational resource (Engelseth et al. 2009) consisting of three interacting layers of transformation in product supply:

1. Information and data which we term the *information flow* involving a complex combining of resources used through informational activities.
2. Products which we term the *product flow* (understood synonymous with "the flow of goods") also involving resource combining and also used in relation to mainly production and logistics activities.
3. Perceptions of supply purpose impacting on decision-making carried out *a network of business actors*. These business actors may (a) own the product through parts of the supply chain, (b) handle but not possess ownership of the product, (c) own the product, but not handle the product. We choose not to discern this as another supply network flow, rather indicate the different business actors responsible for the product and information flow.

All three layers constitute of a combination of resources used through activities. In the product flow the core transformed resource is products, in the information flow the core transformed resource is knowledge. These layers of product, information and knowledge transformation are interdependent and together through interaction support value realisation from an end-user perspective. The flow of information and products together with the network of actors managing these flows are classified representing the main component groups of a supply network as modelled in Fig. 3.

The preceding model is fundamentally based on Alderson's (1965) transvection understanding of product supply involving end-user focus and in a conglomerate (of actors) supply network. At a *sort* (Alderson 1965), the key operational decision-making event in a supply network, information may accordingly be perceived as the

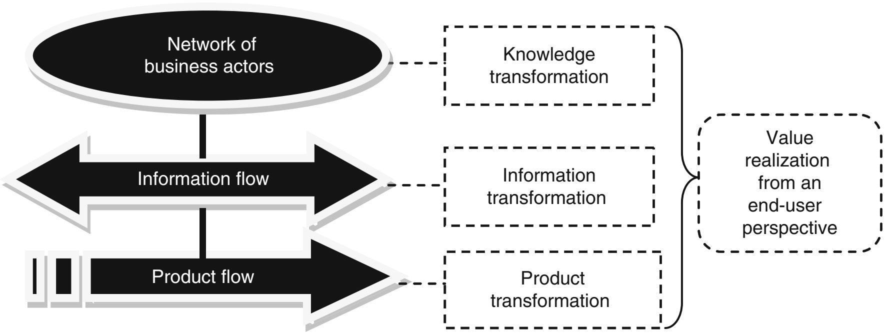

Fig. 3 The vertical aspect of supply network integration

operational glue that holds emergent (therefore dynamic and transformed) product supply *objectives* (operational and strategic) interlinked with product transformations (operations). This interlinking demands a flexible resource, quality information adapted to different types of use. The supply network is accordingly an arena for transformation in three aspects, (1) knowledge, (2) information and (3) products. In this lies the core to value generation. This is the vertical dimension of the supply network involving integration between a knowledge, information and product transformation. Product control upon delivery at a terminal and goods assignment in accordance with orders are examples of such interaction between heterogeneous resource types. The quality of such interaction may accordingly be measured in relation to a "vertical" type of integration quality.

In addition a horizontal dimension is proposed consisting of integration between similar resource types. Similar resource types denote collections of products interacting with product handling resources, information interacting with information handling resources, and knowledge transformation through interaction between actors in a network. A picture of inter-linkage between ISs and ISs as inter-linkages between actors and the product flow is modelled in Fig. 4.

Figure 4 depicts the information flow as a conglomerate of different components. Figure 5 integrates models in Figs. 3 and 4 to create a simplified version of value realisation through horizontal and vertical integration in a complete supply network entity.

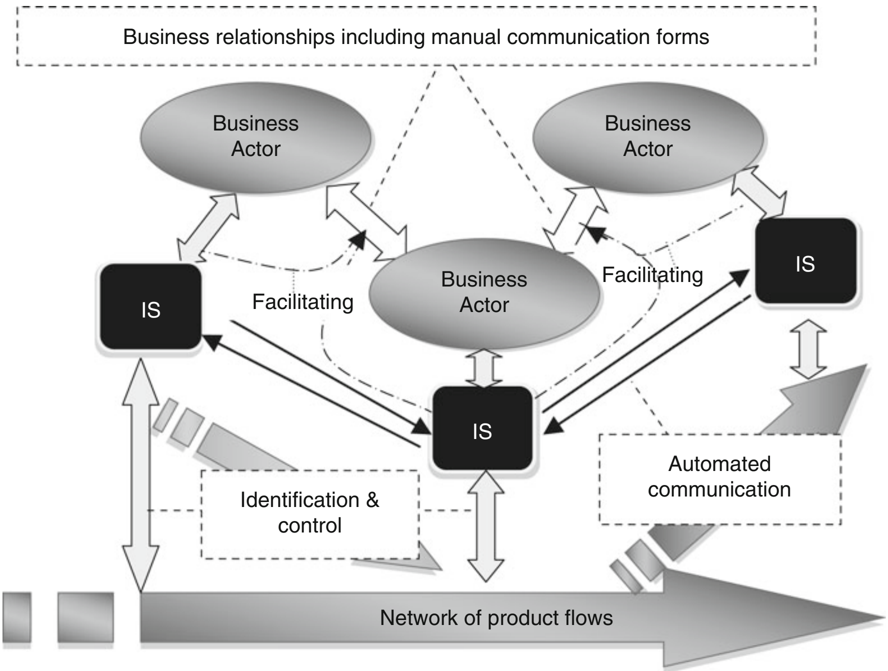

Fig. 4 Key inter-linkages supporting transformation in the supply network from an IS-perspective

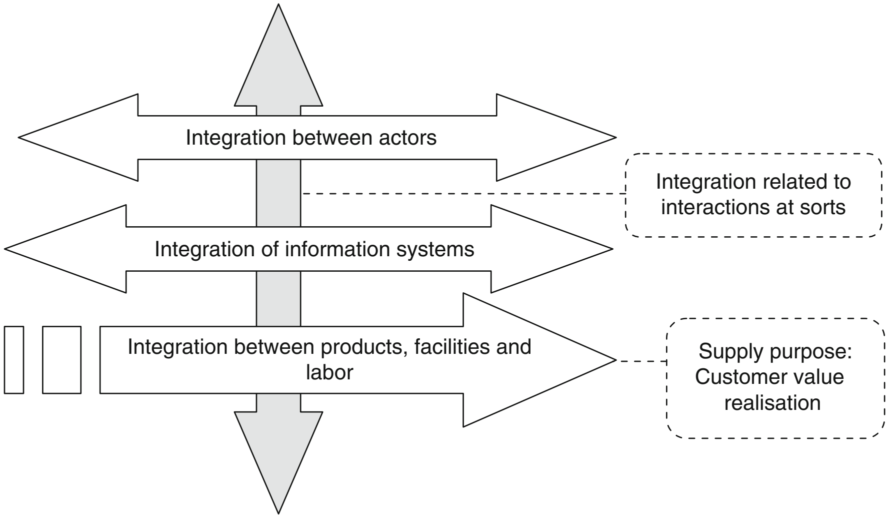

Fig. 5 Dimensions to achieving end-user value realization

Figure 5 describes supply chain integration as involving two main dimensions: integration between sorts (the "horizontal" aspect) and integration at sorts (the "vertical" aspect). Decision-making at sorts is accordingly impacted by layers of transformations interacting technically at sorts.

The provided fresh seafood product case narratives contain many examples that may be interpreted in line with the model in Fig. 4. Taking the perspective of the Aker Seafood Hammerfest management, their knowledge is transformed based on incoming reports of catch, an aspect of the product flow, which comes to their mind based on communications of this catch. Furthermore, retailers become aware of a need to order the Marian product based on information regarding their store inventory level. Changes in inventory of Marian fish products is an expression of product transformation as products are gradually purchased by consumers. Upon sales information from a conglomerate of different retailers is generated and communicated to TINE distribution centres, and onwards to Aker Seafoods; aspects of information transformation. As actors perceive product information their knowledge is transformed.

8 Concluding Remarks

Evoking transformations in supply chains or networks and placing focus on the highly lucid information resource creates a vivid picture of supply network complexity. Models are constructed through the course of this study based on Aldersons's (1965) systems-based transvection approach. Since Alderson passed away even before his 1965 book "Dynamic Marketing Behavior" was published, he left us with the foundations for further developing and modelling his transvection picture of complete product supply. This study represents one such endeavour applied to fresh food supply in particular. The empirical picture depicted in Fig. 2 with sequential transformations towards the evaluating end user is fundamentally based on Alderson's (1965) transvection with limited adaptation from the original model. The models depicted in Figs. 3–5 depict components and inter-linkages involved in a supply network evoked through placing the information flow at core. These models are slices of a complete supply chain or network. As depicted in Fig. 5, information plays a role as a supporting resource in relation to fresh food supply purpose. Transformations in knowledge, information and products between sorts need to be aligned with interactions between these dimensions at sorts. Herein lies an important challenge in fresh food product logistical development; considering the dynamics of resource transformation *between* sorts (inter-organisational perspective) and *at* sorts (intra-organisational perspective). The model in Fig. 5 proposes what is drawn in figure as a vertical and horizontal aspect of integration; the horizontally drawn aspect concerning inter-firm transformation of products, information and knowledge while the vertical aspect concerns intra-firm coordination of transformed products, information and knowledge. From a systems perspective evoking these components (products, information and knowledge) as transformed resources highlights the dynamic aspect of achieving market oriented fresh food supply. Responsiveness is pictured as achieved in a complex adaptive supply network. Due to the particularities of fresh food supply demanding flexible resources to coordinate fluctuations in demand, supply, competition and the environment in general, this provides grounds for simulating not only physical and informational transformations, but also how knowledge transformation is a key factor in achieving responsive fresh food product supply.

This complete supply network-level modelling effort proves foundation for further studies of the nature of and interaction between product, information and knowledge transformation including simulation within a complex adaptive systems framework.

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Exploring the Role of Business Support Agencies in Value Chain Management of the Medical Device Industry

Dakshata Rana and Mike Gregory

Abstract This paper presents a preliminary analysis of the role of business support agencies in medical device value chain (MDVC) development. It takes the concept of local 'business support mechanisms' (BSM) beyond the boundaries of institutional theories and policy constructs to the operational level in the medical device value chain. Companies' requirements are mapped against the business support provisions across the MDVC. This mapping highlights the mismatch of business support provision to industry requirements at different stages of the MDVC. The evidence shows that these misalignments stem from a complex BSM role configuration and an inability to address industry requirements, particularly in the medical device industry, which has unique needs. It is suggested that the concept of roles helps to find a better match between local BSM and the requirements of the MDVC. The value chain development roles played by Business Support Agencies (BSAs) are identified as follows: IP generators, Resource mobilisers, Policy formulators and implementers, Networking agents, and Information mediators. This paper explores the roles of the BSAs in addressing the MDVC requirements. Eight case studies are examined, offering new insights into the roles of BSAs, as well as their attributes and influential factors.

Keywords Business support agencies • Business support mechanisms • Medical device value chain

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science, 393
DOI 10.1007/978-3-7908-2747-7_20,

1 Introduction

Value chain management (VCM) has captured a great deal of attention among academics and practitioners in the past few decades. At present it is attracting the interest of policy makers because of the need to design support systems that meet the industry requirements (UNIDO 2009). This paper aims to explore the links between Business Support Agencies (BSAs) and Value Chain issues in the medical device industry. A BSA is defined as any organization that aims to help local firms start, grow and compete for effectiveness and greater profitability (Gemmell 2009). Business support activities are defined as ‘any activities that support the creation and survival of businesses, increase SME profitability and assist business development and growth. They incorporate information, advice, training and consultancy’ (Gemmell 2009). These definitions are taken from the report by the UK’s Regional Development Agency EMDA. Although this is not an academic report, it provides a solid foundation for this study.

Observations and links between institutions and industry are not new to the body of knowledge included in the fields of Industrial Clusters and Networks, Innovation Systems, Industrial Policy and Economic Geography. Previous work shows that cluster development and upgrading enhance collaboration and synergy among members (Humphrey and Schmitz 1996, 2000; Solvell et al. 2003) and provides a strong foundation for understanding the roles of BSAs in medical device value chain development. Some have argued that public support becomes increasingly obsolete as the cluster continuously upgrades and improves (Humphrey and Schmitz 1996; UNIDO 2009), and when industry needs evolve as they move up in the value chain. Particularly in the medical device industry, the evidence shows that despite increased attention being paid to value chain management and its development, its requirements have ‘not been meet’ for the medical device sector (Burns 2002; Fennelly and Cormican 2004).

This study begins with a description of the background and context for this research, and identifies the knowledge gaps. A summary of the methodology used here introduces the design process by which data from policy and industry have been integrated. In the literature review section, the concept of VCM is examined from various perspectives, such as institutional theory, supply network and cluster theory, with the aim of identifying the investigative dimensions and conceptual framework used in the data collection. The data collection section briefly presents the case data obtained during the field research. This is followed by an empirical study and analysis, which refine the conceptual understandings articulated in the literature. The paper concludes with a summary of the key research findings and the limitations of the study.

2 Research Context

This section reviews global trends in the medical device industry and business support activities for this industry. The structure and characteristics of the medical device industry (MDI)[1] are unique and complex. The products of this industry cover a wide range, from advanced products such as CT scanners, X-ray equipment, and heart implants, which require heavy R&D investment, to surgical equipment such as syringes, gauges and bandages. Like medicine itself, medical devices are essential for patient care. The UK government makes substantial investments in innovation and technology for this industry. According to a study by the United States International Trade Commission (2007), the US, Europe and Japan account for 90% of the total global sales (USITC 2007). In 2000 the industry was worth USD 145 billion. It was worth USD165 billion by 2006, and USD 210 billion by 2008 (WHO 2003; WHO 2010). In 2010 the figure reached to USD 245 billion.

2.1 The Medical Device Industry: Global Trends

Table 1 highlights some of the drivers, strategies and capabilities that define the characteristics of the medical device industry in the leading markets: the US, Japan and Europe. These trends reveal some of the unique characteristics of the industry. It is extremely challenging for small companies to survive in this competitive market place, unless consolidated with larger counterparts or merged with other companies to move up the value chain. In order to be competitive, like any other hi-technology industry, the MDI focuses on innovation, research and development capabilities, intellectual property, strategic alliances, global marketing tactics, distribution networks, a skilled workforce, and regulatory standards to gain a substantial market share and high revenue (USITC 2007). Burns' (2002) studies show that medical device manufacturers compete in five core areas: product innovation, product performance, pricing and contracting, cost of goods sold and customer support services for both advanced products and commodity products, such as orthopaedics, cardiovascular, imaging x-ray products and general surgical supplies (Burns 2002).

As depicted in the comparative table provided (Table 1), some drivers, such as technology infrastructure, technical skills, demographic changes, and the strengths of large and small companies are common to these three markets. The nature of

[1] The definition of the industry and classification of products in the medical device sector may vary from country to country as it is influenced by the specific country's healthcare medical device regulation acts (USITC 2007). According to the EC's, Medical Device Guideline Document (1994), medical devices are defined as products that are used for the propose of prevention, diagnosis, and treatment of diseases and injuries, and the correction of physical deformities of the body.

Table 1 Global medical device industry DCSCs

Country	Drivers	Challenges	Strategies	Capabilities	Source
USA	○ High technology infrastructure	○ Increasing production cost	○ Locational agglomeration	○ Cross-organizational interactions	USITC (2007), de Vet and Scott (1992)
	○ Advanced product innovation	○ High labor costs	○ Inter-connection of producers	○ Breakthrough technologies	
	○ Innovation driven regulatory environment	○ High land prices	○ Subcontracting and formalized contracts	○ Skilled work force	
	○ Formation of new firms for product commercialization	○ Highly regulated market	○ Strategic alliances especially in innovation intensive areas	○ Technology integration	
	○ Opportunities for small innovative firms	○ Slow and expensive product approval	○ Strategic use of M&A to create synergies	○ Home of most of the global companies	
	○ Geographic agglomeration	○ Longer approval time (between 3 and 10 months)	○ Strong public-private partnerships for R&D investment	○ Discounted pricing scales of large firms	
	○ Strong venture capital industry	○ Dampening competition and		○ Scale and diversity of product lines	
	○ Active third party payers	○ High barriers to entry			
Japan	○ Changing demographics	○ Highly regulated market	○ Increase R&D spending	○ SPD (supply, processing and distribution) for cutting costs, reducing labor requirements, and improving inventory management.	Clements (2008), Japan MDC (2007)
	○ 10% share of global medical device production	○ Very slow and expensive product approval process (12–36 months approx.)	○ Promote start-ups ○ Improve clinical trials		
	○ High level of technical skills	○ High trade deficit	○ Expedite reviews		
	○ Strong technical infrastructure	○ Limited access to capital	○ Enhance reimbursement pricing system		
	○ Partial co-payment system	○ Not enough resources for regenerative technologies			

	○ High consumption capacity	○ Slow industry growth			
	○ Competencies in domestic diagnostic market	○ Unique business structure and regulatory complexity (marketing approval, marketing authorization holder, four licenses: marketing, manufacturing, retail and repair)			
Europe	○ Advanced technology infrastructure	○ Increasing production cost	○ Promote Public-Private-partnerships	○ Cutting-edge technology	Fennelly and Cormican (2004), BIS (2009)
	○ Efficient product innovation	○ High labor costs	○ Harmonize regulatory standards with EU	○ Cross-sectorial technology integration	
	○ Strong technical skills	○ High land prices	○ Create strategic alliances specially in the innovation intensive areas		
	○ Strategic geographic location, proximity to the European market	○ Large percent of micro, small and medium sized firm	○ Capture knowledge of European MD clusters	○ Strong influence of biotechnology sector	
	○ Changing Demography	○ Stagnant market growth	○ Strategic use of M&A to create synergies	○ Knowledge partnerships	
	○ Strong venture capital industry	○ High inflation	○ Strengthen SMEs		
	○ Strong network of specialists suppliers	○ Dampening competition and opportunities for small innovative firms	○ Promote supply chain efficiency of GPOs		
	○ Short approval time	○ Low corporate tax benefits ○ High barriers to entry for foreign firms			

such factors as regulatory infrastructure, time taken for device approvals, availability of venture capital and business-angle resources, as well as the participation of intermediaries, strategic alliances, and public-private partnerships are different in these three markets. These factors determine industry strengths and capabilities.

In the USA factors such as homogeneity and economy of scale and scope, availability of venture capital funding, geographic agglomeration, third party payers, and private insurance plans provide unique strengths to the industry. Japan has a unique SPD (Supply, Processing and Distribution) system used by medical institutions in the Japanese healthcare system to purchase medical equipment. It monitors purchase orders in a timely manner, thus providing the following benefits: minimizing inventories, reducing purchases, carrying out a thorough management of inventory and expenses and improving cost sensitivity, managing individual data on usage and consumption, preventing unreported insurance claims, simplifying and improving the effectiveness of purchasing and inventory control, relieving staff workloads, and utilizing space more effectively.

Meanwhile, the European industry has its own strengths and challenges. The life science sector is of critical importance, especially in the UK, Germany, France and Italy. High-tech industries in the life science sector, such as medical technology, medical biotechnology, industrial biotechnology, and pharmaceuticals, play a leading role in meeting the challenges of the healthcare sector, especially in the UK (BIS 2009).

The medical technology sector is a growing sector in the UK, but the future challenges are immeasurable. More than 85% of micro, small and medium sized companies find it extremely difficult to access finances. They have limited internal resources to sustain themselves, are highly regulated, and market short life-cycle products. They also lack the capabilities that large firms have to export products globally, as well as lacking a sourcing power, and highly a skilled workforce. These are some of the critical issues highlighted by various policy papers (CST 2007; Quotec 2009). In spite of the industry's importance, very little is known about its needs and requirements (WHO 2010). BIS (2009) shows that there is a huge need for support for the industry's competitiveness through value chain development (Burns 2002), but there is very little evidence of any support design for the industry.

2.2 Overview of Business Support Activities in General

Business support activities constitute one important public sector strategy for enhancing competencies by resolving the industry's value chain issues. Porter (1998) demonstrates that business support agencies have a significant role to play 'in creating, in partnership with industry and academia, the right (flexible and responsive) environment…, developing existing businesses for the knowledge economy, creating new sustainable businesses, attracting inward investment, increasing exports, providing the correct skills and knowledge for a sustainable economy, the provision of land, property and infrastructure and providing the nation with access to opportunity'. This statement characterizes the roles of business support agencies as mechanisms to create, develop, expand and sustain businesses, and to help them find the right location. As Porter (1998) says, strategies for business support activities are influenced by regional economic strategies and regional business plans. The roles of these agencies are: to create and communicate a distinctive and challenging economic vision in collaboration with key partners and stakeholders, to improve the availability, quality, and cost effectiveness of all components of the cluster, for example to identify engines for growth, to create a context that fosters innovation and upgrading, and to realize knowledge building opportunities to generate cross cluster synergy.

Huge resources are tied up in business for support programmes run by public and private organisations. There are many publications, both policy and academic, about business support for SMEs (Bennett 2003; Wren and Storey 2002). In spite of the large volume of publications on the subject, there is still a lack of understanding of the linkages between the business support mechanisms and industry needs, particularly with regard to the medical device industry. This lack of understanding is due to the changing needs of industry as well as the complex structure of the support system (Williams et al. 2008).

Different countries may have their own unique strategies for business support activities. In the US, apart from supporting innovation and technology in the sector, huge investment is allocated in industry network/cluster development. In his studies, Best (2006) highlights 'investment in sector specific infrastructure' as one of the key business support mechanisms to develop industries. Massachusetts has grown as a centre of MDI. He says it is because of the *region's plethora of research hospitals, which have attracted a disproportionate share of federal R&D funding, which in turn has fostered technology transfer, business spin-offs and created opportunities for medical device companies* (Best 2006).

In Germany, business support mechanisms emphasise the development of *cutting-edge technology* and *centres of excellence*. One report (Matos 2005) on medical technology in Germany highlights some critical factors of German industry's success. In it CEO Ludwig G. Braun, of Braun Ltd says that the success of the industry is due to having the *highest R&D spending* on medical products (Euro 20 billion), *the availability of highly qualified doctors and researchers, highly trained employees, and the most demanding technical standards in manufacturing*. Yet another advantage pointed out in the report is *cooperation between research and industry*. The report also highlights the importance of *centres of excellence* for the success of the medical sector. These 'centres of excellence' are joint efforts of the government (Germany's Federal Ministry of Education and Research), med-tech related researchers, and business communities to work together on specific technologies (Pfeiffer 2009).

3 Research Methodology

This exploratory research originally set out to understand ***how local business support agencies might influence the supply network development of medical device companies.*** Two sub-questions to support the analysis, which are applied to this sector and business support agencies, are: ***How are medical device value chains (MDVC) configured?*** *and* ***How might the local business support mechanisms (BSMs) influence MDVC?***

A multiple case study approach (Yin 2005) was used in this study. The research focuses on two areas: the MDVC and local BSMs. There are many ways to address institution and industry relationships, and there is no agreement in the literature regarding process for establishing the relationships. In this study, case companies define their own particular **institution-industry VC** relationships, provided that companies require different mechanisms and roles to fulfil their needs. A conceptual framework has been developed to present the links between BSMs and the MDVC characteristics (drivers, strategies and capabilities) (Rana et al. 2009). Four in-depth case studies of medical device firms were conducted on the one hand, and four additional studies were carried out on business support agencies on the other. All the cases were restricted to the East of England area, which helped to refine and enrich the conceptual framework.

The criteria for selecting the companies for the case studies were: (a) whether the company plays a significant part in the medical device value chain in the East of England medical technology cluster, and (b) whether it represents a different size and scope. The criteria for selecting the business support agencies for the case studies were: (a) whether they provide support to local manufacturing companies and (b) the kind of support they provide. Because of the small number of cases used in this study, the greatest challenges in this research were reliability, internal validity and generalizability of data. With its rigorous in-depth analysis and theoretical backup, this study has attempted to address these challenges.

Data collection started in March 2008 and continued until the middle of 2010. This process began with a desk study to review the literature, the annual reports of the companies, sector reports, documentation on regional economic strategies, and brochures on regional business strategies and local business support activities. Two sets of interview questions were prepared, one for the companies and one for the local institutions. The second part of the data collection process involved primary data collection, through interviews and visits to companies and local organisations. The industrial issues concerning value chain development were first captured in three different rounds of interviews for each case. In the initial encounter with the companies, data were gathered through semi-structured interviews. Then structured interviews were conducted, and finally the data were presented in group meetings of company and business support representatives for data cross-verification.

Data about the business support agencies were captured through interviews with local departments and key organisations in the East of England region. First, the scope of the agencies' services and their components were captured. The second phase of data collection involved the observation of and participation in Regional level Steering Group Meetings. Three conference papers were written and presented at the international conferences. These numerous visits, telephone interviews, meetings, conference papers and presentations enriched the data obtained from the in-depth case studies.

4 Literature Review

In the 1980s Michael Porter, who popularized the term 'value chain' in the academic community, defined it as the 'entire production chain from the input of raw materials to the output of the final products consumed by the end users' (Porter 1985). Porter's main aim in creating this concept was to enhance the competitiveness of the firm by analysing the primary and secondary activities. He speaks of managing horizontal and vertical competition by studying-value adding activities along the chain. Here 'value' is understood as the price that the customer is willing to pay for the product or service. According to UNIDO (2009), the value chain framework is a tool for analysing the distinctive activities of a firm that can generate core competencies. One can assess core activites, identify cost advantages and develop strategies that can help companies achieve competitive advantages. The approach can be extended from the individual firm to an interconnected set of firms (UNIDO 2009). This section further explores the concept of value chain management.

4.1 Value Chain Management

In the interpretation of Burns, it is called a 'value chain' because each link in the chain adds some value to the original inputs (Burns 2002). According to Porter, value chains are of two types. The first type concerns the 'stream of productive activities within a given firm', which he refers to as the *primary chain*. For example, a manufacturing firm acquires raw materials, capital, and labor, and then integrates and processes these to produce outputs in the form of products and services. The second type concerns the 'stream of activities across firms', which Porter refers to as the *secondary chain*. For example, the output of one firm becomes the input of other firms, and actors as suppliers, competitiors, distributors and end customers are important (Burns 2002; Porter 1990).

The work on value chain management is closely linked with various schools of thought such as: supply chain management (Christopher et al. 2006; Hines and Rich 1997), industrial cluster and networks (Porter 1985; Humphrey and Schmitz 2000), innovation systems and industrial policy (Kaufmann and Wagner 2005; Livesey 2006), and global value chain governance (Sturgeon et al. 2008; Nadvi 2008).

The literature on supply chain management is filled with technical terms such as 'integrated purchasing strategy', 'integrated logistics', 'supplier integration', 'buyer-supplier partnerships', 'strategic supplier alliances', and 'supply chain synchronization' (Tan 2001). Lambert and Cooper (2000) define supply chain management, as expressed and used by the Global Supply Chain Forum, as 'the integration of key business processes from end user through original suppliers, that provides products, services, and information that add value for customers and other stakeholders' (Lambert and Cooper 2000). The concept of supply chain management which became popular in the 1980s, discusses the potential value of integrating chains of activities within such internal business functions as purchasing, manufacturing, distribution and sales (Harland 1996). The concept is constantly evolving with time. The broader understanding of the supply chain can be expressed as the 'management of business activities and relationships in the entire chain' (Harland 1996; Tan 2001).

4.2 MDVC Drivers, Strategies and Capabilities

Mckone-Sweet et al. (2005) note that the healthcare industry has been extremely slow to embrace supply chain management practices in spite of well documented evidence of significant competitive advantages and cost reduction. However, healthcare management has always been a popular area of research (Burns 2002). A study by Burns (2002, 2005) notes that health care product manufacturers operate in a highly complex regulatory environment as highlighted in Fig. 1. The effective management of the value chain is necessary because of challenges such as: short product life-cycle and high cost, the lack of capital for sophisticated technology infrastructure, the challenges of new product development, and excessive inventory carrying cost, to name a few (Mckone-Sweet et al. 2005; Burns 2002; Rochford and Rudelius 1997).

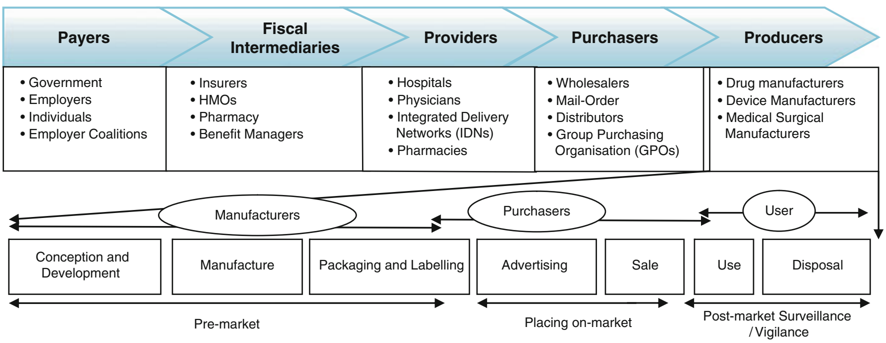

Fig. 1 Medical device value chain (Adapted from Burns 2002; WHO 2003)

In spite of the large volume of literature on supply management strategies, only a few works address the challenges of the healthcare sector (McKone-Sweet et al. 2005) to the medical device industry (Fennelly and Cormican 2004). Hardly any literature can be found which addresses effective MDVC strategies and capabilities (McKone-Sweet et al. 2005) and none for institutional support for MDVC requirements (Rana et al. 2009). Although many authors highlight the importance of public-private relationships from various perspectives such as addressing the risks in supply chains and government's role (Sheffi 2001), high value fruits and vegetables and public support (Narrod et al. 2009) and cluster and value chain competencies and implication of public support agencies (Fennelly and Cormican 2004; Navdi and Halder 2005). Such public-private relationships highlight the benefits of improved collaboration, risk pooling, knowledge development and production links, knowledge flow and product innovation, to name a few.

5 Empirical Studies and Analysis

As the aim here is to develop an understanding of the meaning of institutional roles for MDVC development, this section attempts to provide a detailed empirical description and analysis of medical device value chain requirements and business support mechanisms from the perspective of value chain drivers, strategies and capabilities.

5.1 Mapping of MDVC Requirements

The Cambridge cluster is one of the most important in Europe and is widely recognized for its strength in the life science and health care, IT and Communications sectors (Williams et al. (2008). According to a recent study of the health technology cluster in the Greater South East (Todeva 2008), there are 192 companies in the East of England involved in medical device manufacturing. After the four in-depth case studies were conducted, a cross-case analysis was conducted in order to understand the requirements of medical device value chain. The findings from the cross-case analysis are presented in Table 2. This table captures the critical value chain drivers, challenges, strategies and capabilities and requirements of the four companies for the value chain development of medical devices**.**

As shown in Table 2, micro-sized medical device companies have limited internal capabilities. A critical strategic requirement for value chain development is the ability of companies to maximise their financial capacity in the conduct of research, design and development and in order to fulfil the regulatory requirements of organisations such as the FDA and EC. For cases II and III, the small- and medium-sized medical device companies, certain strategic requirements were critical. They needed to maximise financial and physical capacity, to integrate facilities, and

Table 2 Cross-case analysis summary of MDVC requirements

MDVC activities	Case I	Case II	Case III	Case IV
Research, design and development	Driven by on cost effective technology	Driven by the global gap to target a treatment for Degenerative Disc Disease by developing technical aid for spinal implant	Driven by technological integratability	Driven by innovativeness, regulatory appropriability, technological viability and integratability and sustainability
		The company's Precision Polyurethane Manufacturing (PPM) materials manufacturing technology received a European Patent Grant	Highly uncertain and evolving R&D network	Highly uncertain and evolving R&D network
		Target is transferable to any medical polymer	Alliance with providers, purchasers and producers is critical in the R&D phase	Needs are always changing Operates in a scientifically dynamic environment
Procurement	Supplier for NHS	Critical design and process technology capabilities	Critical design and process technology capabilities, responsiveness, agile and lean process	Critical design and process technology capabilities, responsiveness, agile and lean process, speed and scale and scope, trust, dependability and mutual learning
	Contract based Partnership with short-term focus	High quality control long-term flexible contracts		Economies of scale in purchasing
Production	Production is restrained by the availability of the prototype manufacturing facilities that meets the clinical requirements such as Clean room assembly and Clean room injection	Limited in-house manufacturing capabilities	Production of core technology	Horizontal and vertical process alliances
			Production is conducted through integrated production channel – strategic alliance model	Facilities integration with global partners External internal resources allocation
Distribution	Distribution of product through the GPO	First new product introduction so initially targeting at NHS because ease of access	Partnered with global leader for product distribution	Right time, right quantity strategy

	Conservative and slow adoption of technology	Focusing on strategic alliance with the German and US distributors for value proposition	Involvement of the distributor in the R&D phase as well	Operates in both emergent and mature market segments
	Limited direct business		Critical for long term growth	
	High dependence on the NHS as it has limited capabilities for international distribution		Aims to develop global distribution channel by 2015	
Market and sales services	Small market size	NHS is relevant only at the start up stage	Product is designed and developed for the US market for the initial stage	NHS is of limited direct business importance
	Less significant market for long term growth	US and Europe is targeted for long term business growth		
	Customization and customer service is highly important		Second target market is Europe and Japan	Core market is US, Japan, Middle East and Germany
	Right supply, right time of the components required by hospitals		Third phase market penetration in developing markets like China and India as currently they don't that infrastructure to use the technology	Globally established technology and market

to form various alliances as strategic partnership alliances (vertical and horizontal linkages), resources alliances (HR pooling), incentive alliances (strategic purchasing), and process alliances. Cases II and III are both at the stage in which they are commercializing their unique technologies: they have successfully passed through the clinical trial phase and have obtained FDA 510K, as well as EC approval. Due to their limited manufacturing capabilities, they either have to develop their value chain through strategic alliances or maximize their physical and financial capacities.

Case IV, which is a global player, has its own unique drivers and challenges, which trigger different value chain requirements. The company's key drivers are its high R&D capabilities, its status as a leading innovator, its high R&D investment capacity, its high in-house capabilities for VC functions and skills, its manufacturer-driven global value chain, its possession of fewer competitors in the high end product segments, and its long history of product innovation and development. Thus, for this company, capabilities such as visibility and ability to form an integrative value chain, the capability for innovative technology, trust and commitment, responsiveness and speed are important. For Case IV, the critical value chain requirements are the strategic partnership alliance, resources alliance and process alliance. This company has more than 2,000 1st tier and 2nd tier suppliers, therefore a long term, cost effective strategic alliance is critical for the value chain development. Their facilities are scattered all around the globe, thus without effective process alliances it is difficult for them to achieve value chain visibility.

This study has uncovered seven different factors for categorising MDVC requirements at the strategic level: capacity maximization, technology integration, strategic partnership alliance, resource alliance, incentive, process alliance, and infrastructure optimisation. These factors are critical for the industry's bottom line competencies, particularly with regard to improving the quality standards of the products, reducing the cost of processing and products, improving responsiveness and speed among the horizontal partners, improving reliability and dependability among horizontal and vertical partners and enhancing trust and commitment within the internal and external environment.

5.2 Business Support Activities for Value Chain Development

The data concerning business support activities for the medical device industry, captured from the four case studies of business support agencies, can be broadly categorised into four types: business creation support, business process development support, business expansion support and business sustainment support.

Business creation support activities involve a wide range of strategic, operational and administrative activities that are directed towards the early stage of business development. The support activities range from general, short-term support, such as general business and management advice, marketing advice, business plan assessment, and access to office premises, business management training and general management training. Case A facilitates networking activities among the stakeholders, such as knowledge partnership management, integration of stakeholders, and the use of networking events to facilitate contact between the key actors of the industry. Case D focuses on providing state-of-the art facilities and ISO standard labs for biotech and medtech enterprises, while in Case C, one of the core activities was to provide flexible facilities for high tech companies are provided by Case C and D. New venture opportunities, administration handling, meeting rooms, and conferences. Business creation support activities that included start up and spin-off support were targeted towards high technology companies (Case C), bio technology and medical technology companies.

Business process development activities focus an activities such as promoting innovative technology breakthroughs (All cases) and awards and incentives for innovative technologies (Cases A, B, C). Apart from activities enhancing innovation and technology, two of the cases provide consultancy services for process benchmarking, are review of bottlenecks (Case B, D). Although such activities are important for the value chain, their business support efforts seemed to lack the necessary resources, tools and techniques to target sectors like a medical device companies. The business expansion support activities' provide franchise management (Case B), and general support, such as providing market information for trade shows and assisting customer management (all cases). Finally, the business sustainment support activities focus mainly on investing in skill and training programmes in Enterprise Centres, and green infrastructure development (Case C).

Like any other manufacturing industry, the medical device industry focuses on performance criteria, such as quality standardisation, cost reduction, responsiveness, speed, visibility, reliability, dependability, trust and commitment. None of the support services examined here were directly targeted towards enhancing value chain visibility or integrating value chain activities from the pre-market phase to the placing on-market or post-market phase. Responsiveness, trust and commitment, reliability and speed were identified as critical elements in the medical device cases. Moreover, it was observed that the companies invested large amounts in strategic partnership alliances, supplier selection, supplier training and development, and the building of long-term partnerships to increase responsiveness, reliability and trust among vertical and horizontal partners. However, no tools or proper direct support is evident provided by the business support agencies. Figure 2 maps these business support activities against the value chain activities.

5.3 The Roles of BSAs in Value Chain Management

Based on the above discussion, this section analyse the gap between the needs of the companies and the services that business support agencies supply. Certain roles that could be played by BSAs in value chain management are identified as important in addressing these gaps. Table 3 illustrates the gaps between MDVC requirements

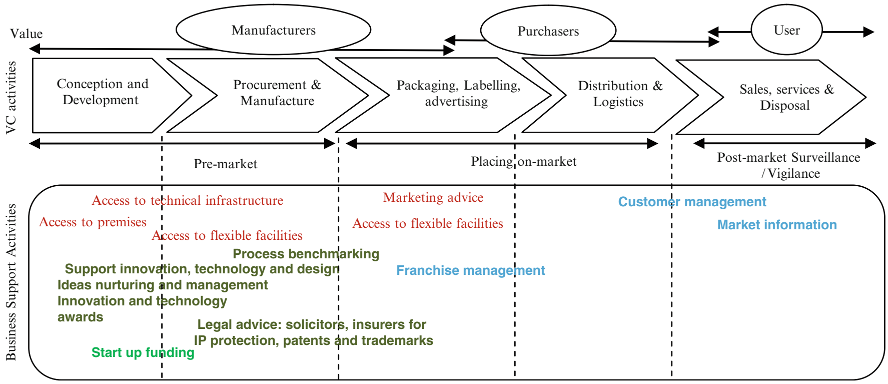

Fig. 2 Mapping of business support activities

against the business support that is provided, as observed in the case studies. This map of 'demand and supply' helps to identify the types of business support that will address MDVC requirements. The table also shows that even though some support structures address some MDVC requirements, there is still a substantial mismatch between the industry needs and support provisions. This mismatch is due to the current level of business support coordination and effectiveness, and the complexity of business support structures.

Table 3 shows that business creation support addresses the infrastructure optimisation requirements of the value chain. Thus we can say that the existing infrastructure has the tools and capabilities to address non-value adding activities of the value chain, but that it still lacks the ability to address incentives alliance and process alliance requirements. This ability may be critical for integrating different activities of the medical device value chain activities particularly activities of the pre-market stage and the placing on-market stage in the value chain as shown in Fig. 1.

Business process development support is effective in the upstream activities of the value chain, such as design, development and conceptualisation, and also in clinical trials, and prototype development through supporting innovation, technology and design, idea nurturing, and knowledge exchange as seen in cases A and B.

Activities such as processes benchmarking and bottleneck reviewing, are important for the companies. These supports are not quite addressing the requirements of the strategic partnership alliance between the actors in the value chains, such as payers, providers, purchasers and producers, where the scope of customers and payers is totally different in the healthcare industry, as shown in Table 1 and Fig. 1. Because the drivers for payers are healthcare cost reduction, process streamlining, HR downsizing and they monitor this through high degree of standardisation, while the drivers for producers are high level of funding to mitigate design failure, specialised human resources, visible supply chain to address a few.

Table 3 Gap analysis of MDVC requirements vs. business support provided

Business support classification/MDVC requirements		Capacity maximization	Facilities integration	Strategic partnership alliances	Resource alliances	Incentive alliances	Process alliances	Infrastructure optimization
Business creation support	General business and management advice	X	X	X	√	X	X	√
	Access to technical infrastructure	√	√	√	√	X	X	√
	Marketing advice	X	√	X	X	√	X	√
	Flexible facilities	√	√	X	√	X	X	√
	Business plan viability assessment	X	X	X	X	X	X	√
	Access to office premises	√	√	X	√	X	X	√
Business process development support	Support for innovation, technology and design	√	X	√	√	√	√	√
	Nurturing and management of ideas	X	X	√	√	√	√	√
	Knowledge exchange	X	√	√	√	√	√	√
	Technology advice	√	X	√	√	√	√	√
	Legal advice: solicitors, insurers for IP protection, patents and trademarks	X	X	√	√	√	√	√
	Innovation and technology awards	X	X	X	√	√	√	√
	Process benchmarking	√	√	X	X	X	√	X
	Bottlenecks review	√	√	X	X	X	√	X
	Green technology support	√	√	X	X	X	√	√
	Investment in ICT	X	√	X	X	X	√	√
Business expansion support	Franchise management	X	X	√	X	X	√	X
	Market information	X	X	√	X	X	√	X
	Trade shows	X	X	√	X	X	√	X
	Customer management	X	X	√	X	X	√	X

(continued)

Table 3 (continued)

Business support classification/MDVC requirements		Capacity maximization	Facilities integration	Strategic partnership alliances	Resource alliances	Incentive alliances	Process alliances	Infrastructure optimization
Business sustainment support	Financial management and access to finance	√	X	√	√	X	X	√
	Start-up funding	√	X	X	√	X	X	√
	Financial access advice	√	X	X	√	X	X	√
	Identify better sources government grants	√	X	X	√	X	X	√
	SME banking schemes	√	X	X	√	X	X	√
	R&D credit management	√	X	X	√	X	X	√
	Regulations and standards	X	X	X	X	X	√	√
	Employee contract assessment	X	X	X	X	X	√	√
	Union negotiation	X	X	X	X	X	√	√
	Patent and trademark protection	X	X	X	X	X	√	√
	HR and workforce support	X	X	X	√	X	√	√
	Skill provisions	X	X	X	√	X	√	√
	Staff interviews	X	X	X	√	X	√	√
	Staff benefit schemes	√	X	X	√	X	√	√

Business expansion support addresses the need to identify new markets through activities such as franchise management, market information provision, trade show hosting and customer management (cases A, B, C, D). However, it still does not address such issues as capacity maximisation, facilities integration, resource alliance, and process alliance, which are critical for the integration of the entire value chain as seen in the MDVC cases requirements.

Business sustainment support which addresses support such as financial management, regulation and standards, HR and workforce development which is also some of the very important drivers for MDVC. Example of misalignment is seen at the infrastructure optimisation of MDVC where industry is encountering issues like challenge of retaining high skilled staff, high risk of venture failure at early stage, time required for regulatory approvals, passing of clinical trials, which puts heavy financial and HR burden on companies and are critical for companies sustainment.

One way to highlight the mismatch between the business support activities provided by the government and industry needs is to use ‘role theory’. Knight and Harland (2005) note that, according to the role theory, ‘roles are evoked by situations’ and can be seen as clusters of behaviours expected of parties in particular statuses or positions (Knight and Harland 2005). Researchers seem to have adopted two distinct perspectives on roles. One is centred on structure, and the other on action and interaction. The later may be and it may be advocated by symbolic interactions as well such as position in the organisation. Knight and Harland (2005) argue that ‘an actor in a network can be viewed as a collection of roles’. Roles are seen as context-specific, and are negotiated between the role enactor and role senders. This paper uses the work of Knight and Harland (2005) to identify six roles which business support agencies play in addressing MDVC requirements (Table 4).

6 Conclusions

This paper has sought to identify a process for establishing links between industry requirements and local business support provisions. Attempts has been made to offer new insights into industry and institutional links by (a) mapping MDVC characteristics against strategies and activities (b) compiling a generic list of MDVC drivers (c) listing MDVC requirements and (d) carrying out an analysis of a business support mechanisms. This four-step analytical process has led to the identification of five BSM roles for the purpose of MDVCs development and upgrading.

Two arguments have been made in this paper. First, that value chain requirements for the medical device industry are triggered by the unique value chain drivers, challenges, strategies and capability requirement of the industry. The characteristics of these value chain requirements seem to be influenced by the companies’ size and scope. The value chain map (as shown in Fig. 1), showing

Table 4 The roles of BSAs in MDVC development

Roles of BSAs/types of BS activities	Business creation support	Business process development	Business expansion support	Business sustainment support
IP generators	✔ Provide knowledge for innovation and technology	✔ Invest and develop centre of excellence	✔ Facilitate innovative spin-out from universities and industry	✔ Provide resources and skills for new and sustainable technology and process
	✔ Facilitate innovative start-ups	✔ Provide resources for value-adding manufacturing	✔ Exploit innovative platforms	✔ Monitor technology uptake
	✔ Support research and exploitation	✔ Indentify new process and technologies and communicate		✔ Invest and promote in sustainable technologies
	✔ Provide incentives and awards for new innovative projects	✔ Protect breakthrough technologies		
Resource mobiliser	✔ Challenge resources of public agencies to the promising business and sectors	✔ Foster knowledge transfer of new process within and across sectors	✔ Provide knowledge and advise on new market, routes to market and cost effective distribution channels	✔ Invest skills and advance and technical knowledge
	✔ Provide needed tangible and intangible resources to the start-up companies	✔ Mobilise skills and HR capabilities between and across industries		✔ Invest in technical infrastructure
Policy formulators and implementers	✔ Set policy for competitive business environment for new business	✔ Set standards for policy of product design, manufacturing, regulatory approvals, and market entry	✔ Set policies and standards for strategic alliances, market expansion, joint ventures	✔ Monitor the operations of free market and economy for business expansion
	✔ Monitor and structure relationships between parties	✔ Set standards for new processes and provide trainings and updates	✔ Implement suppliers development programmes	✔ Analyse cost and benefits of new standards and processes
		✔ Promote and invest in ICT		✔ Facilitate cross breeding of technologies
		✔ Provide VC development skills and trainings		

Networking agents	✓ Provide contact and resources to small business ✓ Facilitate networking meeting between the various stakeholders of the industry	✓ Bridge gaps between horizontal and vertical partners ✓ Organize meeting and conferences between the horizontal and vertical partners ✓ Help identify key suppliers, business partners	✓ Help companies set up trade shows locally and globally ✓ Help identify potential market	✓ Identify partnerships and collaborations at local and global level within or across sectors
Information mediators	✓ Provide required information to small businesses	✓ Monitor mis-communication between horizontal and vertical partners ✓ Monitor interfaces between research, design, manufacturing, distribution and market and service	✓ Coordinate implementation of EU market regulations	✓ Coordinate and administer activities of public and private sectors

the links between actors, activities, and products illustrates the complex eco-system, that is the fundamental basis for value chain requirements as they evolve.

Second, the evidence found on business support mechanisms indicates that even though a support structure exists to address some MDVC requirements. There is still a substantial mismatch between industry needs and support provisions (as shown in Table 3) This mismatch is due to the current level of business support process coordination, the complexity of business support structure, the limitation of resources and the lack of clarity in roles.

To prepare the way for a further analysis of this misalignment, and to work towards addressing it, this investigation has identified five value chain development roles that Business Support Agencies can play to help the medical device industry. These roles are as: IP generators, Resource mobiliser, Policy formulators and implementers, Networking agents, and Information mediators.

Several areas of further research are suggested. First, these roles should be used for a further analysis. This analysis needs to have a rigorous methodology to explore the misalignments at the different levels of value chain such as: the organizational, strategic and operational levels. Second, a comparative analysis can be conducted with other life-science sectors, such as biotechnology and pharmaceuticals. Third, cross-country or cross-regional comparisons of business support mechanisms can be carried out to determine the best support mechanisms for certain targeted industries.

There are a number of potential limitations of this exploratory work such as a limited number of case studies, study is limited to the East of England, limited insights on in-depth financial analysis and technical issues, business support mechanisms is limited to local level, and analysis is limited to codification and pattern matching rather than rigorous quantitative analysis of the larger sample study. These limitations would be addressed through study of a broader spectrum of cases differing sizes, sectors and technologies, and study of specific business support mechanisms across different clusters and regions. The highlighted gaps needs be refined and tested robustly in further work.

Acknowledgments The authors are grateful to Dr. Sally Church for her valuable comments and for proofreading this paper.

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H. Jodlbauer et al. (eds.), *Modelling Value*, Contributions to Management Science,
DOI 10.1007/978-3-7908-2747-7, © Springer-Verlag Berlin Heidelberg 2012

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