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Designing Pilot Projects as Boundary Objects

A Brazilian Case Study in the Promotion of Sustainable Design

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Preface

Systemic changes that aim at more efficient and sustainable patterns of production and consumption demand a collaborative Design approach. Collaboration, and the resulting shared knowledge, is a key pillar for developing and implementing strategic innovations towards sustainability and valued co-production. Indeed, collaborative networks can be valuable to induce the improvement of skills among individuals and organizations, as well as developing Design policies to support local development. This work assumes that a strategic and collaborative Design Pilot Project (DPP) is a valuable mechanism to trigger the evolution of a fragmented local system with poor environmental and social records and with management and innovation issues as well. This topic is addressed through an action research method, using the collaborative network conceptual model (ICoN) proposed by the research. An assessment tool with five indicators—environmental, technological, economic, socio-cultural and organizational—was also conceived to identify emergent patterns on the local context derived from the DPP implementation.

The field study was in Brazil and integrated a complex collaborative system formed by representative spheres of the Triple Helix—wooden furniture Micro and Small Enterprises, the Design School of the Federal University of Uberlândia/MG, SEBRAE and SENAI, the Local Government and the Union of Furniture Manufacturers. Under the leadership of the university, this approach aimed to stimulate the emergence of new relation modalities, which could result in new paths of action to develop the region as a whole. As knowledge can lead to individual skills when articulated into practice, the DPP (named MODU.Lares Project) started with the establishment of consensual goals, stimulating synergy and encouraging commitment among participants.

By using the Boundary Objects as a theoretical framework, four elements have catalyzed the flow of knowledge in this collaborative network: Prototypes, Meetings, Exhibitions and the Pilot Project (as a complete process). The results have demonstrated that a DPP can be a valid instrument to motivate an environment towards the creation of collaborative networks, particularly in contexts with a poor associative culture. They also indicated feasibility for being a broad strategy tool to induce local Design policies. Such a Project can be the first step of a

design policy cycle in developing countries, thus contributing to defining ideas and objectives among local stakeholders in a collaborative fashion, minimizing risks of failure and increasing the chances for governmental support. The DPP was a valuable element of connection, since it was the first time in the region that a group of organizations (businesses and otherwise) were involved in a collective project with a collective objective from which everybody benefitted.

Viviane dos Guimarães Alvim Nunes

Acknowledgments

A lot of them. Because to thank is not only about the thesis—above all, it is an experience in life.

First of all, I would like to thank the sweet and musical presence of my family that in all circumstances of my life has stimulated my choices and given me unconditional support, without judgment or criticism.

I am very thankful to my supervisor Francesco Zurlo who generously shared with me far more than his knowledge, but also his simplicity and capacity to see the world in 360°. Now, as friends, we have the opportunity to collaborate and continuously share ideas and impressions. I would also like to thank Prof. Dr. Aguinaldo dos Santos for his competence and very important considerations that contributed to improving the results of this research.

I acknowledge the National Council for Scientific and Technological Development (CNPq), Brazil, for sponsoring the Doctorate in Design at the Polytechnic of Milan—POLIMI /Italy.

Finally, I would like to express my gratitude to the individuals and organizations involved in the Pilot Project, which believed in this experience as an opportunity for improvement and evolvement, not only for the furniture sector but for the local context as well. In particular, I thank the entrepreneurs who collaborated with their time, money and efforts trying to contribute as best they could for the successful results of the research.

To all of you, I wish fruitful future researches that inspire wider collaborative networks. I sincerely hope that this experience has been only the beginning of a series of successful collaborative experiences in the region to effectively consolidate our path towards sustainability through Design.

Viviane G.A. Nunes

I would like to thank Viviane for sharing this important research work with me. This is not an arrival point, but a starting point, and I will we can continue together, in order to reflect on many issues of design policies and design

management, which are useful in all the situations having similarities (mature sectors and undifferentiated products, low propensity to collaboration, SMEs with problems of strategic competitiveness, low attention to the issues of market and technological innovation, unawareness of the environmental concerns).

I have learnt a great deal from her, and I am sure I can learn a lot.

My special thanks are also due to Prof. Dr. Aguinaldo dos Santos of the Federal University of Paraná/Brazil (UFPR), for the expert and accurate contributions to this research work. Moreover, particular thanks go to all the actors that took part to this research project, without whom it would be difficult to verify some of our insights.

We hope that this action model can be replicable in other contexts, with similar characteristics, in order to improve the sustainable and competitive performances of the companies.

Francesco Zurlo

Contents

Acronyms

ABDI	Agência Brasileira de Desenvolvimento Industrial (Brazilian Industrial Development Agency)
ABIMOVEL	Associação Brasileira das Indústrias do Mobiliário (Brazilian Association of Furniture Industries)
APL	Arranjo Produtivo Local (Local Productive Arrangement)
CSPD	Centro São Paulo Design (São Paulo Design Center)
DMI	Design Management Institute
DPP	Design Pilot Project
FIEMG	Federação das Indústrias do Estado de Minas Gerais (Federation of Industries of the State of Minas Gerais)
GCI	Global Competitiveness Index
HDF	High-Density Fiberboard
ICoN	Inter-organizational Collaborative Network
ICSID	International Council of Societies of Industrial Design
IEL	Instituto Eduvaldo Lodi (Eduvaldo Lodi Institute)
LCA	Life Cycle Assessment
MDF	Medium-Density Fiberboard
MDP	Medium-Density Particleboard
MP	MODU.Lares Project
MSE	Micro and Small Enterprise
NGO	Non-governmental Organization
OSB	Oriented Strand Board
PBD	Programa Brasileiro de Design (Brazilian Program for Design)
PD	Product Development
PPE	Personal Protective Equipment
R&D	Research and Development
SEBRAE	Serviço Brasileiro de Apoio às Micro e Pequenas Empresas (Brazilian Micro and Small Business Support Service)

SENAI	Serviço Nacional de Aprendizagem Industrial (National Industrial Learning Service)
SINDMOB	Sindicato das Indústrias de Marcenaria e Mobiliário do Vale do Paranaíba (Vale do Paranaíba Furniture Union)
SME	Small and Medium-sized Enterprise

Chapter 1
Introduction

Abstract The purpose of this Chapter is to present the theme developed during the Doctoral Research in Design which approached the idea of a Design Pilot Project as a strategy of collaboration between different organizations. The chapter describes, in a general presentation, the context of the intervention, the theoretical framework, the expectations and results as well as some contributions to knowledge, which are further detailed in the next chapters.

Keywords MODU.Lares Project · Inter-organizational Collaborative Networks · Sustainable practices · Action-based experience · Micro and Small Enterprises (MSEs) · Uberlândia/Brazil

1.1 MODU.Lares: A Design Pilot Project Experience

This work is the result of a Doctoral Thesis in Design developed at the Polytechnic of Milan/Italy, from 2010 to 2013. The research approaches the idea of a Design Pilot Project (DPP), named MODU.Lares Project, as a strategy for collaboration among different institution types, in fragmented contexts with poor environmental and social records and with management and innovation issues, which therefore need a strategy for local development. The theoretical framework uses the references of Boundary Objects as facilitators of communication at the boundaries, as described in Chap. 2. The study also presents a case study based on a specific Brazilian context.

The project's name—MODU.Lares Project—was defined to refer to some local experiences in the city of Uberlândia/MG as well as to a project dimension. In Portuguese, *MODU* means MÓveis De Uberlândia (i.e. Furniture of Uberlândia) and *Lares* means Home, thus comprising the human and subjective dimension of using or having a house. It also refers to the *modular* dimension adopted within the work to design the prototypes.

As a contribution to knowledge, the research proposes a conceptual model of an Inter-organizational Collaborative Network (ICoN) in order to define the most

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important connections among the participants of the proposed network, their roles and their pattern of relations, during a defined long-term project or planned activity. In accordance with the Triple Helix model, in which relations are mainly established among the university-industry-government spheres, the ICoN model also includes other types of institutional partners, such as social organizations and Unions to provide a broad network of actors in order to amplify the potential of this collaborative network.

The ICoN Model suggests that interactions among partners can be more or less intense, depending on the profile of participants (i.e. their background, potential for pro-activeness, capacity for communication etc.). The intensity of relations also influences the level of attention to results expected by the collaborative work. Regarding the pattern of relations, the ICoN Model suggests that they can occur: (a) through continuous and/or intermittent contacts; and (b) through direct and/or indirect contacts, which depend on the scope of the project, the participants involved and the strength of the partners' engagement.

The research has shown the relevant interrelation between different issues within an organization itself, such as managerial and organizational, socio-cultural and environmental issues (as well as the significance of an integrated and collective network among organizations of different nature) in order to innovate with co-production value and to sustainably progress. Surveys and further desk research also revealed that the delivery of collaborative and sustainable practices and innovation are directly associated with the individual entrepreneur's capacity to visualize value and opportunities, and the willingness to acquire new knowledge and adopt new—procedures.

Even when social contagion is expected to occur—due to the similar features of stakeholders—the process is neither continuous nor certain. It is crucial to investigate the openness to partnerships in diverse contexts and the likelihood of integrating new Design and manufacturing paradigms. In order to adapt to a co-productive relationship, testing more efficient production practices and to make a final analysis of artifacts possible, a furniture collection was designed, prototyped and discussed collectively by the Micro and Small Enterprises (MSEs) involved in this study.

Within the scope of the research an Assessment Tool was created in order to evaluate the DPP. It was intended to identify emerging changes and to orient strategies for future interventions in similar contexts. This Assessment Tool was based on five main aspects (environmental, technological, economic, socio-cultural and organizational), individually explored further in finer subjects, thus providing quantitative data to assess the results.

The study unveils a broad range of visions on individual responsibilities related mainly to sustainability, which frequently compromise the cohesion of the group and the achievement of greater outcomes. Moreover, the huge difficulty of facing the managerial issues, both individually and collectively, represents a strong barrier. The diversity of visions was discussed taking into consideration the relevance of the contexts, e.g. the political, economic, environmental and socio-cultural aspects in which groups—whether individuals or organizations—are embedded, when analyzing new paradigms and behavior-changing strategies.

Considerable attention was devoted to the implementation of the action-based experience in order to obtain representative elements for the trial and its analysis. Although the impact effectiveness was a little different from what expected, at this time a significant contribution of this work is associated with the remaining knowledge among the partners involved in the Project. Considering all the limiting historical conditions, with remarkable individuality of actions, the lesson obtained from the MODU.Lares Project execution can be used as a mechanism to carry out other collaborative work activities engaging the same group, a part of it or even other groups, in order to achieve greater effects.

Finally, the results point out the value of the MODU.Lares Project in fragmented contexts, in which no collaborative culture or no policy exists, by amplifying the generic design policy model proposed by Raulik-Murphy (2010).[1] For the author, there is usually a limitation to completing the policy process due to no ratification by the government. Hence, in similar cases, a Design Pilot Project carried out as the MODU.Lares was can trigger a collaborative culture among partners, therefore strengthening the feasibility of government agreement, as argued by Nunes (2013). The better identification of either a problem or an opportunity, before starting a cycle of design policy, contributes to minimizing the risk of failure and increases, in consequence, the chances of successful policies and outcomes.

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[1]The model is based on an eight-step process: (1) identification of an opportunity, idea or problem; (2) consultation with experts and representatives; (3) well-defined proposal as basis for political and government intervention; (4) ratification of the process by the government; (5) resource allocation and formulation of the plan; (6) implementation; (7) results; (8) evaluation.

Chapter 2
Research Design

Abstract This Chapter presents the research approach adopted as research strategy to carry out this investigation. It describes the research problem, the assumptions and questions as well as the methodology used to developed the work. The chapter describes the research process and explains the action-research method adopted to implement the Design Pilot Project experience in Brazil. Finally, the main theoretical references used and the assessment model developed within the scope of this research are synthetically presented, to be further discussed.

Keywords Brazilian Strategic Design Pilot Project · Wooden furniture sector in Brazil · Boundary objects

2.1 Problem

Understanding the highly fragmented design system in the context of this work requires some background information. Uberlândia is a medium-sized city in the Minas Gerais State, Southeastern Brazil. Geographically placed in a strategic position, it is considered the main logistics center of Latin America, and its tertiary sector (e.g. commerce and services) is the most relevant for the local economy (about 70 %) (SEPLAN 2009).

Firstly, it is worth clarifying that the definition of the strategic orientation and management of any business or enterprise depends on its characteristics. However, there are no universal criteria to define it. Many indications have been used to classify enterprises as micro, small, medium and/or large-sized categories, but these classifications are not completely adapted to all situations, thus varying according to the contexts.

Definitions can either be relevant for tax reasons or to establish criteria to identify eligible enterprises in order to receive government benefits (Lima 2001), as shown in Table 2.1. Since a company's size is related to the market it operates in, there will often be companies that fall outside a particular classification, which may well be suitable for inclusion (Storey 1994). Thus, in order to define the

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Table 2.1 Definitions of micro, small and medium-sized enterprises

Agency enterprise\ category	Bolton Report 1971[1]	European Commission 2005[2]	Statute of MSE[b] Brazilian Law 77/2011[3]	SEBRAE (Brazilian Service of Support for MSEs)[3]
Micro-sized	Owner managed	<10 employees ≤ € 2 million[a] (previously not defined)	≤€ 149 thousand[a] (until 2010 € 93 thousand)	<19 employees (industry/building sector) <9 employees (commerce/service sector)
Small-sized	Financially independent	<50 employees ≤€ 10 million[a] (in 1996 €7 million)	≤€ 1.4 million[a] (until 2010 € 930 thousand)	20–99 employees (industry/building sector) 10–49 employees (commerce/service sector)
Medium-sized	Small market share	<250 employees ≤€ 50 million (in 1996 € 40 million)	(non-defined)	100–499 employees (industry/building sector) 50–99 employees (commerce/service sector)

Sources [1]Bruce et al. (1999); [2]European Commission (2005) and Muller et al. (2014); [3]SEBRAE (2012)
[a]annual turnover
[b]MSE—Micro and Small Enterprise

group of micro and small companies that are part of this research, the references of SEBRAE (2012) were adopted.

In general, the existing MSEs in Uberlândia have different development levels. Due to their limited skills in many aspects, only a few of them have a feasible potential for adopting more efficient and sustainable practices as well as innovation paths. Most of these aspects are related to design skills, managerial issues and operations mainly verified in their complex company facilities, as well as relations with different actors (SENAI et al. 2006).

To make carrying out DPP development easier, partners were selected according to similar levels of facilities, managing practices and target markets of the MSEs involved. Even though still lacking, these companies presented better conditions compared to other competitors with regard to renovating design practices, production by co-productive practices and management issues. Such a perspective included the potential for improving environmental, economic and technological performances, comprising new social and cultural values in their relationships with stakeholders.

The history of the furniture sector in Uberlândia reveals a slow progress in the enhancement of product and service performance. Indeed, the only existing diagnosis to analyze the sector was carried out by SENAI in 2006. From that analysis, a series of recommendations concerning the technical, technological and managerial issues was proposed for the sector. However, none of them was implemented

until the beginning of this field study in 2012. Among the recommendations proposed by SENAI et al. (2006), the most relevant were:

- Improvement of managerial practices: an action plan for improving MSEs in the furniture sector, starting from the basic concepts of management and their implementation;
- Collaboration as strategy to improve knowledge: to explore personal skills and foster participation. The report advised the adoption of a plan based on practical knowledge concepts to support: (a) production processes through standardization; (b) technical issues and Design; (c) relations and networking and (d) co-development of abilities;
- Understanding market demands: to provide enterprises with support for identifying clients and for understanding marketing methods and investments;
- The execution of a Pilot Project as a strategy to encourage collaboration: a cooperative action trial to obtain benefits in scale, in distribution or in brand communication. The report emphasized the need for a coordinated investment, to sustain compromise within the group, as well as the crucial engagement of the company leaders.

Despite being proposed in 2006, those recommendations were still aligned with the furniture sector scenario in 2012. Since MSEs have always operated in individual and isolated ways, collaboration was quite absent among them. Such behavior resulted in the reduced impact of their decisions at strategic, tactical or even at operating levels, as well as limiting their capacity to obtain financial subsidies or economic incentives to invest either in R&D or in focused consultancies.

In relation to the manufacturing systems, the MSEs' tailored-to-consumer orders often generate problems of different nature concerning the companies' technical and managerial inefficiencies, including the capacity to handle market research and environmentalproblems. In short, the status of their performance is described by: (a) loss of time and high costs; (b) inappropriate material selection and lack of optimization; (c) products with difficult assembly/disassembly systems; and (d) lack of a flow of orders.

2.2 Assumption and Questions

The research assumed that a strategic Design Pilot Project, developed in a collaborative way, could trigger the beginning of an evolution towards the sustainability of a fragmented local system with a poor record in sustainability issues, as well as in managerial and technological aspects. Such a project regarded a network-based experience, which engaged actors with different organizational types. Even though the questions were focused on a Brazilian context, they can be associated with other contexts, either in developed or in developing countries, with similar conditions related to micro and small businesses and fragmented design systems.

The main research question was: *'How can a Design Pilot Project* (*and the objects generated through its implementation*) *be used as a Boundary Object*

element? References of Boundary Objects (Star and Griesemer 1989; Carlile 2002; Fong et al. 2007) and 'common language' were adopted to help propose a collaborative model to interact and produce. This started from the creation of a common understanding, to stimulate synergy and encourage commitment.

Other three complementary issues were considered:

- *Can a Design Pilot Project be used to improve technical and environmental solutions, as well as socio-organizational and economic issues, for MSEs in the furniture sector?* To answer this, a Design Pilot Project with the furniture sector was proposed. The focus was to trigger collaboration and behavioral changes within MSEs partners, and also to demonstrate to the local government the relevance of creating design policies.
- *What are the actual benefits of sustainability efforts in building up a collaborative network towards innovation and competitiveness within MSEs?* Analyzing the importance of collaborative networks to motivate both individuals and organizations, as well as to contribute to innovation performance, to change and to growth development, building up a network was extremely relevant to increase benefits.
- *What is the impact of the intervention obtained with a Collaborative Design Pilot Project developed in a fragmented local context with a poor record in innovation and sustainability concerns?* Pilot Projects are known for their value to improve knowledge, produce economic benefits, reduce environmental problems and to learn about the innovation context interaction. Thus, a Pilot Project represented a chance to assess the actual outcomes achieved by its execution, in order to verify the effectiveness in triggering the beginning of an evolution toward sustainability through collaborative practices (Fig. 2.1).

In its whole, the Pilot Project was considered as a Boundary Object element, i.e. an instrument of common language (Carlile 2002), which addresses both direct

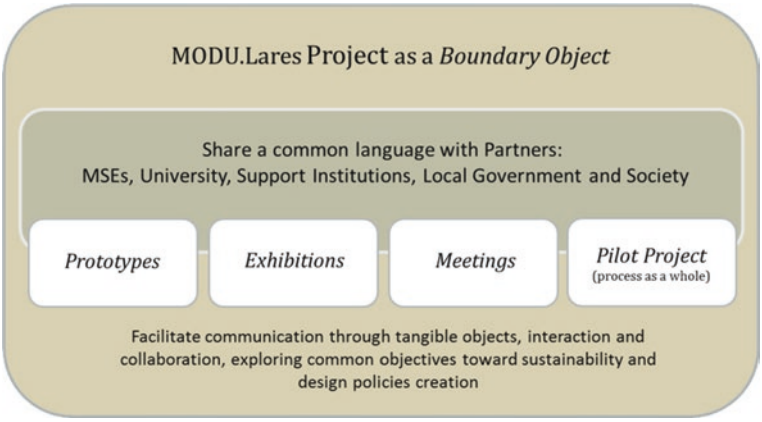

Fig. 2.1 Diagram of Pilot Project as a Boundary Object (elaborated by Nunes 2013)

stakeholders—enterprises and government—as well as indirect stakeholders—users, education sector, environment, market. The improvement of system skills and of the abilities to follow a sustainable path and more competitive directions was the major expectation of the Pilot Project trial.

2.3 Methodology

2.3.1 Research Process

The research process followed three main phases (Fig. 2.2): (a) a First theoretical phase, with literature review, theoretical framework, case studies; (b) a Second *action research* phase, related to the MODU.Lares Project action planning and execution, divided into five steps; and (c) a Third theoretical phase, with the Assessment of outcomes, Discussion and Recommendations.

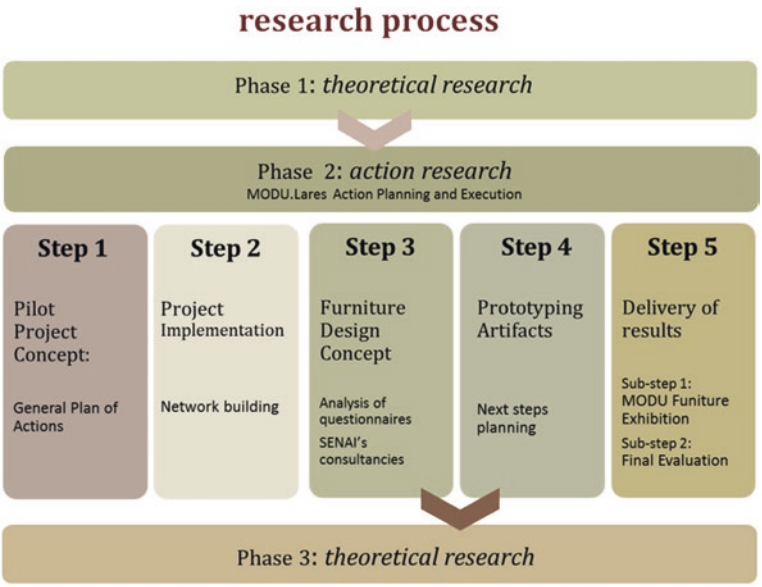

Fig. 2.2 Scheme of the research process (based on NUNES 2013)

2.3.2 Action-Research Phase

The DPP developed in an 18-month period aimed at making the wooden furniture sector evolve in relation to various issues, such as collaborative actions, design thinking, technical, manufacturing and innovation solutions, market strategies, socio-cultural attention and sustainability concerns. Beyond triggering collaboration and behavioral changes within partners, the Pilot Project aimed to demonstrate to the local government the relevance of creating sustainable design policies for the region.

Such a proposal was supported by the understanding that good action strategies could enable viable solutions to respond to problems or even explore opportunities. Therefore, contextualized strategies could support the development of new concepts for MSE operations in such a fragmented local system, in coordination with tactical and operational decisions.

Since Pilot Projects are considered collective experiments and strategic tools to test technical, socio-political and economic configurations of an innovation (Latour 1999) and can be adopted for scaling up processes (Pound et al. 2003; Snapp and Heong 2003), they represented a feasible instrument for action. Pilot Projects can, therefore, be designed to serve multiple functions also in transition management, thus making them an attractive instrument for diverse social problems and contexts (Loorbach 2007).

Based on these issues, the Design Pilot Project was defined as a strategy to implement a collaborative environment and to try the proposed actions.

2.3.3 Literature Review and Conceptual Framework

The The main references adopted were:

- Collaboration, as a valuable approach to embolden learning (Brna 1998; Lopes and Baldi 2009), to pursue collective outcomes (Jansen et al. 2008; Hocevar et al. 2011), and to empower shared resources (Kloth and Applegate 2004);
- Innovation, from Schumpeter (1934) to several other authors (Swan et al. 1999; Ahuja 2000; Akrich et al. 2002; OECD 2005; MacCraw 2006; Tsai 2009; Croitoru 2012; Gopalakrishnan and Damanpour 1997; Bucolo and Matthews 2010, 2011);
- The role of Design in seeking better solutions (i.e. in products, processes, services and even strategies) (Zurlo 1999; Mozota 2003; Best 2006; Rossi Filho et al. 2009) and their implementation. This includes the Design Management perspective (Mozota 2003; Best 2006) as a response of individuals to their businesses (even the micro and small sized) (Cooper and Press 1995; Bruce et al. 1999), its effective use by companies (Gorb 1990), either at the corporate or at the project level (Topalian 2003);

- Sustainability, to favorably orient the attainment of environmental stewardship, economic growth and social progress (Elkington 1994; Manzini and Vezzoli 2002; Ljungberg 2005; Morelli 2007; Tischner 2010), and also to face other problems (of an organizational, managerial and marketing nature, as well as related to social cohesion).

The conceptual framework adopts the Boundary Objects (Star and Griesemer 1989; Carlile 2002, 2004) as facilitators of communication at the boundaries (Carlile 2002). As defined by Star and Griesemer (1989), Boundary Objects are elements that are sufficiently flexible to adapt to local needs but still specific enough to maintain a common identity across different interpretations. This means that "their structure is common enough to more than one world to make them recognizable" (Star and Griesemer 1989, p. 393).

2.3.4 Assessment Tool

Approaches to achieve the transition level towards more sustainable operating conditions were found in many authors (Elkington 1994; Winograd 1995; Sachs 2002; Manzini and Vezzoli 2002; Redclift 2003). Based on these approaches, it is possible to argue that the use and preservation of natural resources, as well as the maintenance and propagation of diverse social, technological and responsible productive practices, are feasible solutions toward sustainability.

In order to identify any emerging change in the MSEs' performance and the participants' behavior, thus perceiving how to solve problems or guide future experiences and strategies (Kloth and Applegate 2004; Hocevar et al. 2011), it was important to evaluate the intervention.

The indicators that integrate the MP Assessment Tool were defined on the dimensions of sustainability approached by the ICoN established with the MODU.Lares Project. They are then converted into specific issues, to be further analyzed by using mainly quantitative data. The MP tool was intended to be simple, in order to provide a broad vision of the MSE before and after the intervention.

The MP tool makes it possible to visualize the current and future scenario of MSEs, thus helping to guide actions and decision making processes. Despite some limitations, for the scope of this research the MP tool was a useful instrument which helped to visualize the current situation of MSEs. It also helped identify emerging changes generated from the pilot project's development. The assessment tool is presented in the next chapter.

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Chapter 3
The MP Assessment Tool

Abstract This chapter describes de Assessment Tool developed within the scope of the research to understand the emerging changes in the context of the intervention, which are possible thanks to the Design Pilot Project implementation, as well as to orient strategies for future interventions. This Tool was developed based on five main indicators—environmental, technological, socio-cultural, economic and organizational indicators, which were further explored, individually, in specific issues, thus by providing quantitative resources to evaluate the results. A Radar map was used as a means to visualize a broad image of the scenario, analyzed in two different moments of the Design Pilot Project.

Keywords Evaluation tools · Environmental, technological and economic indicators · Socio-cultural and organizational indicators · Indicators of MP Assessment Tool in Brazil

3.1 Introduction

In literature, many tools have been adopted to analyze products, services or processes with an environmental focus[1]. Among those available to environmental product development, each one has a different level of complexity, which can be used either on the micro-level or on the macro-level (e.g. companies, public policies). Depending on the context of the application and the aim of the evaluation, the tools can vary from checklists to highly elaborated computer-based expert systems, including technical strategies such as material substitution or dematerialization (Baumann et al. 2002).

To obtain an overview among the many tools identified, Baumann et al. (2002) classified them into six different categories: frameworks, check-lists and

[1]Guelere Filho et al. (2008) set some tools used to evaluate the environmental impacts of products and processes, such as: Life Cycle Assessment (LCA), The Eco-Function Matrix, MET-Matrix, Life Cycle Design Strategies (LiDS-wheel), Design for Environment Matrix, among others.

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guidelines, rating and ranking problems, analytical tools, software and expert systems and organizing tools.[2] However, the authors have identified some difficulties to achieve the potentialities of sustainable design in companies. Among them, it is worth highlighting that the lack of integration of such tools with the b context of product development, as well as with competition and co-operation processes, is also mentioned. From the business standpoint, for Roome (1994), the development of sustainable businesses and the adoption of environmental concerns into business strategies demand new forms of thinking about the existing structures and systems.

Notwithstanding the relevant arguments of Baumann et al. (2002) about the creation of new tools, the complexity and specificity of the existing tools would demand a really difficult analysis of all the elements involved in the MODU.Lares Project. Moreover, as the aim of this evaluation was to both provide a broad image of the Project during its development and to visualize its future effects to solve problems (instead of supplying a detailed description of each of the selected issues) the assessment tool was proposed.

The five indicators that compose the MP tool[3] (environmental, technological, economic, socio-cultural and organizational) were all approached during the MODU.Lares Project. They were then converted into specific issues, guided by combined references from the literature (Maxwell and van der Vorst 2003; Ljungberg 2005; Parker and Ford 2009; Tischner et al. 2009),[4] to be further analyzed by using mainly quantitative data (Colorni 2012). The MP tool was defined based on the notion of rating problems (Colorni 2012), due to their relative simplicity and the limited need for data (if compared to LCA, for example) (Baumann et al. 2002).

It is important to underline that the MP tool does not cover all the possible comprehensive aspects or the variable elements that should integrate a complex intervention, which limits the attainment of more structured assessment results. Since the tool was developed within the scope of this research, it does not offer a general model to be adopted in different contexts i-n its totality. However, even though this instrument of evaluation is partial and applicable in this context of

[2]Frameworks contain general ideas about possible guides for environmental considerations in the Product Development (PD) process and are often followed by a group of tools and technical strategies. Check-lists and guidelines are, usually, tools of a qualitative nature (few are semi-quantitative) and are used to check the fulfillment of a requirement. Rating and ranking tools are, in general, simple, quantitative tools and typically adopt a pre-defined scale for evaluating the impact on a specific phase of PD. Analytical tools are preferably of broad quantitative scope for measuring the environmental performance of products. Organizing tools guide the planning of a sequence of tasks or the cooperation among specific business functions with the involved parts, helping to integrate sustainability concerns as a company strategy (Baumann et al. 2002).

[3]The MP tool denomination refers to **M**ODU.Lares **P**roject and is used to distinguish it from mentioned other assessment tools.

[4]References from Maxwell and van der Vorst (2003) regards the optimization of: functionality, environmental materials impact; social impacts of materials; economic aspects. From Tischner et al. (2009): relations with stakeholders, health and safety, market position and competitiveness, partnership and cooperation, macro-economic effect. From Parker and Ford (2009): relationships, meetings and discussions, participation, shared design processes, prototyping and learning. These aspects were analyzed and grouped by Nunes (2013), according to the indicators.

Table 3.1 Levels of profiles

Main level	Percentage	Level of obtained results	Transition phase
A	$\geq 95 = 100$ %	High	AB or BA: $\geq 85 \leq 95$ %
B	$\geq 75 \leq 85$ %	Very good	BC or CB: $\geq 70 \leq 75$ %
C	$\geq 50 \leq 75$ %	Good	CD or DC: $\geq 45 \leq 50$ %
D	$\geq 30 \leq 45$ %	Low	DE or ED: $\geq 25 \leq 30$ %
E	$\geq$ Zero ≤ 25 %	Insufficient	

analysis, it is also possible to affirm that, with a few modifications, the tool can be extended to other ambits. Moreover, despite these limitations, and thanks to the support of a final Radar map, the MP tool was highly useful to visualize the existing scenario and the potential changes among the MSE partners in the DPP, thus obtaining indications for future strategies.

3.2 Explaining the MP Assessment Tool

The five indicators and some sub-indicators that compose the MP tool are used to define the final profiles for the group analyzed. This intends to provide values to point out whether some movement was noticed with the intervention or not. Five main levels and four transition levels were defined (Table 3.1) (Colorni 2012):

Additional tables (see the appendix) contain the calculating process for each indicator, by using a percentage or an equation. The data used to fill in the tables of indicators were based on different sources, such as data regarding the facilities and equipment and SENAI's consultancies report, data on the current use of materials, data on planned material, data of relationships, meetings, shared actions.

3.2.1 Environmental Indicator (EvP)

The environmental limits and the irreversible effects generated from production and consumption processes demand radical changes to reduce 90 % of resource consumption (Manzini 2006). Decreasing the use of resources through correct conceptual design proposals influences the reduction of overall costs, therefore the gains can be shared among stakeholders. This indicator comprises technical aspects, interaction issues, and also a new way of dealing with products and processes, e.g. selection, usage, maintenance, re-use/recycling, and disposal (Elkington 1994; Manzini and Vezzoli 2002a, b; Manzini 2006; Vezzoli 2007).

3.2.1.1 Specific Environmental Issues Analyzed

- *optimizing consumption* (minimizing resources, material and energy): through a functional approach, the project focuses on all manufacturing processes and not just

on the object in itself. It includes evaluation of the control of material consumption, particularly of waste. These practices contribute to reducing energy consumption, waste generation and, also, to reducing time and energy to select and classify waste.[5]

- *re-use and recycling*: the reintegration of useful waste before it is discarded contributes to avoiding the production of new components or entire artifacts, within or outside the company. It is worth noting that waste treatment is usually more expensive and harmful than the process of selecting useful waste for re-use.
- *low impact process*: the adoption of new principles and concepts applied to processes, products and services, to new consumption models. On this regard the assessment also serves to check the level of air quality (inside the MSE) by verifying whether particle collectors are used.
- *selecting certified and safe materials and resources*: selection of materials and energy with a low environmental impact, i.e. the use of non-toxic materials, from natural and renewable sources, which can be recyclable and biodegradable, easy to disassemble and re-use.

3.2.2 Technological Indicator (TcP)

The technological issues aim at assessing the improvement of existing facilities and managerial practices as well as the adoption of more advanced machinery and technology. This indicator includes issues related to sustainable design concepts and co-production practices, in order to improve quality, increase know-how and optimize infrastructure.

3.2.2.1 Specific Technological Issues Analized

- *low cost production x better performance*: the optimization of the design project intends to simplify production. The modularity adopted in artifact design aims at increasing performance through a rational use of materials and components, achieving faster manufacturing and customization (color, compositions and furnishings) at a lower cost.[6]

[5]A possible option for the local context could be the Pull Type system—or Make-to-Order process in which production is based on: (a) the demand side and starts only after a customer's order is received; (b) actual demand assigned to later processes (Hopp, Spearman, 2002). In Make-to-Order processes the production management capacity is central to resolving the conflict between manufacturing and marketing functions, ensuring that the company allocates the available capacity to satisfy customer demand in an efficient and effective fashion (Sridharan 2000).

[6]Based on Da Silveira et al. (2001), Da Rocha (2011) presents a wide taxonomy that entails eight generic levels of mass customization: (a) design: collaborative design, production and delivery of a product based on clients' needs; (b) artifact production according to client preferences; (c) assembly: combination of modular elements into different mixes; (d) additional client work into a standard product; (e) additional services in a standard product; (f) packaging and distribution of products in different ways; (g) modification of usage; and (h) standardization without customization. For Da Rocha (2011), mass customization types seem to exclude one another. However,

- *easy assembly/disassembly and adaptability*: flexible joint systems allow to easily assemble and disassemble, either by permitting the addition of new parts or the substitution of parts without damaging the object'' original structure (Ljungberg 2005; BSR 2008; Federlegno-Arredo et al. 2010)[7];
- *share design (creation process):* increasing know-how by conceiving new products or services in a collaborative process with diverse partners aims at understanding the perceived improvement in skills by working and learning together in a network of partners;[8]
- *Share production processes (MSEs):* the interaction level between companies to co-produce intends to increase the value and capacity of production by optimizing infrastructure, lead time and know-how.

3.2.3 Socio-Cultural Indicator (ScP)

Associated with the continuous learning process, this issue aims at improving skills and reaching common results, which are crucial for successful innovations (Porter and Krammer 2006; Parker and Ford 2009). Although behavioral changes take a long time to effectively provoke actual changes in the real world, the design approach that deals with social equity continues to be a non-stop goal for those who seek sustainable solutions, particularly in developing countries (Papanek 1985; Elkington 1994; Porter and Krammer 2006; Morelli 2007).

3.2.3.1 Specific Socio-Cultural Issues Analyzed

- *improving skills and sustainability awareness*: learning new collective manners of behaving and working implies the stakeholders' interest in sharing knowledge and better practices (Ceschin 2010). This also demands new partnership patterns, with a convergence of interests in and an awareness of a systemic optimization of resources.
- *delivery/address of social interests*: this aspect intended to confirm the delivery of artifacts to Brazilian C and D economic classes as well as to verify if the proposed collaborative network included (among others) specific social bodies among the partners, such as schools, social centers, NGOs, local associations.

Footnote 6 (continued)

within this research, solutions tried to combine some of the aspects mentioned, such as: (a) assembly, thus creating different mixes according to the clients' needs; (b) additional client work into a standard product; (c) use: the modification of the product during use by the client.

[7]The existing assembly system adopts nails and glue, with minimal flexibility. The second evaluation used data of the artifacts prototyped in the research. The calculation memory is not presented in this work due to its complex data.

[8]The sharing of design processes is included due to the initial intention of gathering elements of design and production in the same indicator. This aspect can be reviewed in future work to improve the MP, thus integrating the socio-cultural or the organizational indicator, for example.

3.2.4 Economic Indicator (EcP)

This indicator assesses the perception of increased production capacity and competitiveness in the organization. Its issues also expect proximity to market needs through the company portfolio, by offering novel products, services and creating new business (Hardy et al. 2005).

3.2.4.1 Specific Economic Issues Analyzed

- *increased competitiveness*: this intended to measure the capacity to deal with market demands through interdependent actions. If production capacity intensifies, hence increasing the likelihood of reducing costs, competitiveness can also increase. This aspect is, however, only valid for cost-sensitive markets.[9]
- *increased production capacity*: the increase of production capacity was a way to measure the volume of production obtained from the prototyping experience.

3.2.5 Organizational Indicator (OrP)

This refers to the capacity of both connecting heterogeneous actors to work collectively as a platform, to create products and/or services and to share knowledge and information both inside the involved group and with outside entities. The empowerment of an interdisciplinary group to work in a complementary way is an important condition to develop innovations (Parker and Ford 2009).

3.2.5.1 Specific Organizational Issues Analyzed

- *Connecting actors and enabling collaboration*: interactions are vital to strengthen the group involved in a collaborative project, as a way to achieve better final results. Collaborative networks, however, demand time and evolve in time, which means that actors can change along the process (Gilman 1990; Marchica 2004; Tomael et al. 2005).

[9]The competitiveness in production includes several variables such as flexibility of volumes, speed, flexibility of mixture and of costs, brand communication as well as the capacity for dealing with the supply chain as a whole. However, the setting of the main issues and their importance to the pilot project occurred in accordance with MSEs. They were then systematized by Nunes (2013), to compose the MP tool. This actually resulted in some limitation of the assessment tool.

- *Sharing knowledge and information*: this intended to learn about how MSEs perceived the value of the connections established for gaining knowledge and accessing new information.

3.3 Mapping the MSEs' Profiles

A Radar Map was adopted to provide a visualization of the final values found in the tables of indicators (see the appendix). Figure 3.1 illustrates the generic profiles of a MSE, and the level of attendance to indicators.

The profiles indicate five main levels (A, B, C, D and E), and four transition levels (T-AB or T-BA; T-BC or T-CB; T-CD or T-DC; T-DE or T-ED). The aim is to classify the level of MSE operations, in terms of best performances regarding the indicators of the MP tool. The higher the MSE's level [*i.e.* from E (lowest) to A (highest)], the better is its performance and, thus, its profile.

The values from the final tables are then shown in Table 3.2 and must be gathered in three lines: (a) two main levels and one transition level; (b) two transition levels and one main level, including the initial average (*Ai*). At this point, it is necessary to select four values at least (corresponding to the indicators, which can include or not include the initial average [*Ai*]). Then, the final average (*Af*) that defines the MSE profile is calculated from the collected values. In the cases in which all indicators are inserted into the selected area the final average (*Af*) will correspond to the initial average (Ai) (see the appendixes), (Fig. 3.2).

The Radar Map shows that, in both analyses, the MSE fits into the predefined profiles (i.e. three indicators are inside the borders of the level boundaries). Although there are other aspects that can be included in similar analyses, to

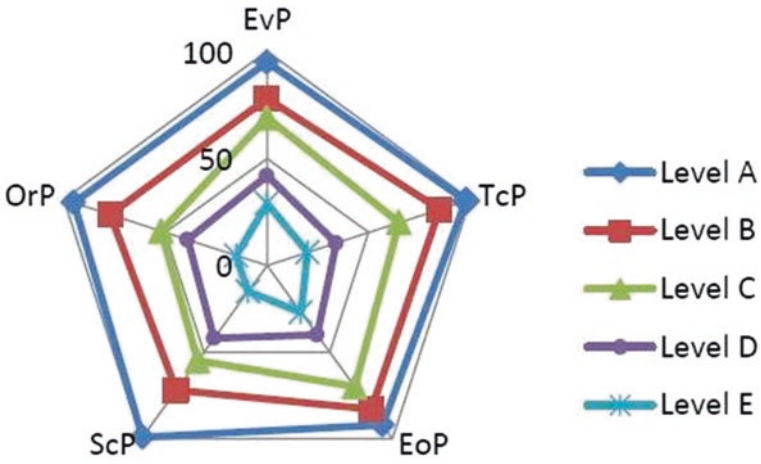

Fig. 3.1 Mapping the MSEs' profiles

Table 3.2 Example of a MSE Profile

Level	Values	Indicators Before*							Indicators After**						
		EvP	TeP	EoP	ScP	OrP	Ai		EvP	TeP	EoP	ScP	OrP	Ai	
E	0 - 25			10		20									
Transition ED	25 -30				27			Af							
D	30- 45						32				40				
Transition DC	45- 50		48												
C	50- 70	55										52	67		Af
Transition CB	70- 75													70	
B	75- 85														
Transition BA	85- 95									92					
A	95-100								100						
Final Level		Transition LEVEL ED							LEVEL C						

[a]The first assessment (June 2011), based on the analysis of questionnaires and data from MSEs
[b]The second assessment (June 2012), after the prototyping and exhibitions, based on the analysis of questionnaires, data from MSEs, data from SENAI's report (SENAI-CETAL/FAM 2012)

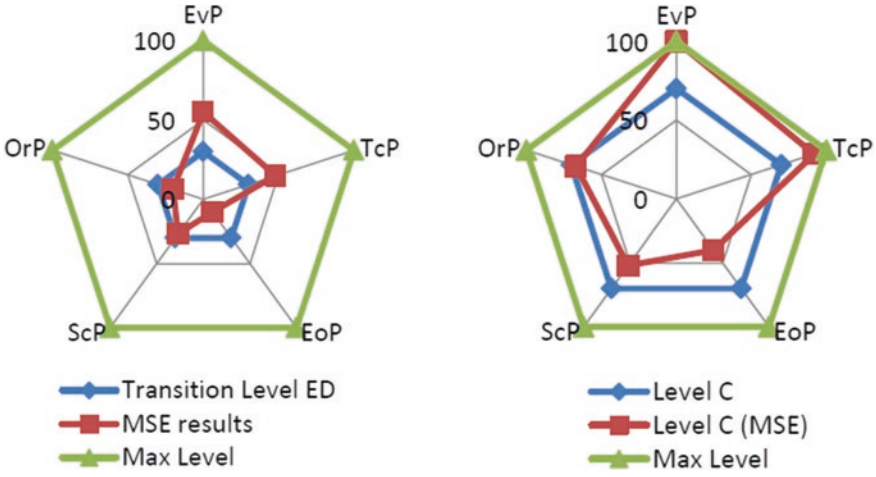

Fig. 3.2 Radar Map (illustration of profiles)

achieve higher precision, within the scope of this study, the tool helped to visualize the current situation of MSEs and to identify changes emerging from the pilot project development.

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Chapter 4
Theoretical Background

Abstract This Chapter discusses arguments on collaboration and innovation through design, the importance of inter-organizational collaboration and collaborative networks as a means to build skills and improve MSE conditions, which are central to this research. The role of Design Pilot Projects for innovation as well as the issues of Design Management and strategies to achieve better managerial and organizational levels are also addressed. Moreover, two important subjects are discussed: (a) the role of Boundary Objects as elements that enable a *common language* in order to build a new knowledge among participants in collaborative processes; and (b) the *'system-ability'* issues that help in local changes as well as in processes to scale up the transition towards more sustainable scenarios.

Keywords Innovation · Design Pilot Project · Boundary Objects · Collaborative Networks · Co-production Value · Sustainability

4.1 Literature Review

Considering a system as a set of structures that together perform a function, the term *system-ability* is defined by Nunes (2013) to approach the idea of enabling abilities (i.e. capacities and skills) through the creation of a collaborative network among actors with different skills and roles, who will act together to make such a system function. This *system-ability* may also be coordinated to the 'sustain-ability' term, i.e. it refers to the capacity of sustaining an intervention that is environmentally and socially responsible by building a collaborative network.

4.1.1 Collaboration and Innovation Within Networks

Information and knowledge are valued resources that contribute to creating and maintaining social networks, where each participant brings a personal background

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knowledge and cultural identity (Tomael et al. 2005). Such conditions can help to compose a cohesive wholeness and to promote change towards sustainability by acting collaboratively in favor of common interests. From a business perspective, as isolated interventions have been less effective when dealing with global challenges, strategies implemented through a network perspective are more likely to succeed in the long-term (Tomael et al. 2005), due to the contribution of each partner to the collaborative environment.

Integrating these networks becomes a competitive factor, especially for MSEs. Due to their internal weaknesses (e.g. lack of financial and human resources such as knowledge, management skills and market vision as well as limited technology) and difficulty in understanding external threats or opportunities (e.g. environmental concerns), operating in collaboration represents an opportunity to face problems collectively (Van de Ven 1986; Swan et al. 1999; Lopes and Baldi 2009). Increasing the awareness of such internal and external aspects will help strengthen innovation in these socio-economic networks (Atherton and Hannon 1999).

Company networks typically include organizations, such as suppliers, buyers, competitors, regulatory authorities and other economic institutions (Marchica 2004; Tomael et al. 2005; Tsai 2009). For Di Pace (2013), such a network is a contract that allows companies to share activities and resources, in order to improve the operations related to those activities and to strengthen entrepreneurial competitiveness. According to Ricciardi (2010), a network of enterprises can be described as

> a set of legally autonomous companies, in which relationships are based on trust and, in some cases, on contracts to orient joint investments assumed to carry out a common production (Ricciardi 2010, p. 2)

Due to the combination of factors such as economies of scale and of learning as well as process innovation, from an economic perspective, the network of enterprises signifies an overall reduction of operation costs in comparison with those demanded by individual production by each single company. Moreover, the reduction of fixed costs impacts positively on the operational risks and on the value of the companies that compose the network (Ricciardi 2013).

In Italy, for instance, about 95 % of companies are considered Micro and Small Enterprises, with fewer than 10 employees. Over time, however, because of their productive and commercial skills, even in challenging systems, such MSEs have demonstrated their ability to adapt to dissimilar contexts. They have also inventively proven they can effectively use the available material and immaterial resources. The awareness of their lack of production capacity and the need to overcome the barriers established by property ties have induced many Italian MSEs to position themselves alongside the classic management mechanisms of regulation as, for example, cooperation relations based in the network structures (Ricciardi 2010). Companies interact with one another, even if they are competitors—they share information, machinery, personnel and even orders (Perrow 1992).

As discussed by some authors (Marchica 2004; Tomael et al. 2005; Tsai 2009), collaborative networks integrate other types of institutions that support companies in the learning processes, whether in humanities or in technological fields. Through this, the flow of knowledge and information resulting from the exchange,

as well as resource sharing among involved participants, will function to enhance innovation and evolvement, in addition to focusing on contextualized problems.

Rosenfeld (1996) exemplifies that in 1989, the Danish Technological Institute created a program to: (a) offer training programs for people who would identify opportunities and facilitate co-operative ventures; (b) foster the design, development and implementation of co-operation among three or more companies, by funding their activities; (c) support the publicity campaign. Such efforts were based on the belief that the capacity of co-operative behavior could help Small and Medium sized-companies (SMEs) to survive in the market, because collective work would allow companies to innovate through collaboration, to develop R&D projects as well as to share knowledge. The author also suggests that the Danish case, combined with the Italian case, stimulated other European countries to adopt similar programs for SME networking, as can be observed in Spain, the United Kingdom and Portugal (Rosenfeld 1996).

Collaboration is, indeed, a valuable approach to embolden learning (Brna 1998) involved in the pursuit of collective outcomes (Jansen et al. 2008; Hocevar et al. 2011), and to empower shared resources (Kloth and Applegate 2004), thus increasing the services offered by collaborators. However, there are still many challenging stages for companies, especially MSEs, organizations and even individuals, to engage in collaboration and collaborative networks.

Some authors (McCormack 2001; Kloth and Applegate 2004; Tellioğlu 2008; Hocevar et al. 2011) argue that the key step of successful collaboration is to negotiate the common goals, the roles and the available structure of each participant. When formulated cooperatively, these definitions minimize failure. The participative approach must also reserve room for debate and revision, thus refining added goals during the development of the collaborative process, as a continuum (Tellioğlu 2002, 2004; Parker and Ford 2009).

For Ricciardi (2010), the efficiency of a network of enterprises depends on its solidity. The factors that favor its survival over time are mainly related to: (1) the level of reliance established among the partners; (2) the exchange of information and knowledge; (3) the presence of a planning system. Todeva and Knoke (2005) and Tsai (2009) argue that the engagement in partnerships within inter-organizational collaboration networks depends on the actual partnerships purposes, the features of the organizations and on multiple environmental factors. Positioned on different levels, each factor comprises specific issues to address change and performance improvement (Todeva and Knoke 2005; Tsai 2009).

However, the interdependence of actions within such collaborative networks can impact positively or negatively on the system, depending on the intentions, the quality of relationships and the choices made to face problems. This occurs due to the interconnected reactions of dimensions and means that organizations must operate by a logic composed of three essential elements: the individuals, the environment and the technology (Todeva and Knoke 2005).

In this way, solutions to identify internal problems and the definition of common goals must encompass the external dimensions of such a system. Since viable solutions to the lack of resources and capabilities are not often available within a

single company (Das and Teng 2000), inter-organizational collaborative networks constitute an important instrument to operate in order to achieve innovative and more sustainable solutions.

According to Ricciardi (2010), and based on a research carried out by Unioncamere—Chambers of Commerce of Italy, companies which operate in networks have a 17 % higher competitive positioning in respect to those that operate alone. Furthermore, in the districts in which these networks of enterprises operate it is possible to verify that their profits are also higher compared to those from the same sector that do not cooperate. This demonstrates that SMEs, when structured in a network, obtain the advantages of large companies without the need of combination or incorporation operations, thus increasing their facilities in a virtual manner.

In this competitive context, Design can take on a central role, not only to collaborate with qualified knowledge, but by motivating the building of scenarios that permit to seek better solutions in projects, processes, services and even strategies (Zurlo 1999; Mozota 2003; Best 2006; Rossi Filho et al. 2009). The Design field can even support the execution of such solutions, by managing design processes in order to reach successful outcomes (Mozota 2003; Best 2006) in the dimensions involved in the collaborative process. Additionally, design can also act on the promotion of pilot initiatives that foster the creation of contextualized design policies integrated with the idea of these inter-organizational collaborative networks as a mechanism for the sustainable development of a region.

4.1.2 Innovation and the Role of Pilot Projects

Innovations are generally analyzed according to three dimensions: (i) the process of development, adoption and diffusion; (ii) the place (i.e. structure) in which innovation occurs—industry, organization or department; (iii) the innovation itself (i.e. types), identified as products or processes, radical or incremental, technological or non-technological, projects or social innovations (Gopalakrishnan and Damanpour 1997).

As for collaborative networks, the favorable results for each type of innovation depend on both the context and the group involved in its development process, which will (or will not) favor its diffusion. Actually, diffusion depends similarly on the internal and external relations which the involved group establishes during the innovation process. This determines adoption by social cohesion or not (Burt 1987). Although innovation can provide many benefits for companies, institutions, individuals and society, as a whole, some difficulties in managing its dynamics are noticed.

From the design perspective, designers integrate scientific knowledge and insights into creative solutions, thus producing innovations to generate new offers (e.g. products, services or processes) (Owen 2007; Brown 2008, 2009). The advancement of the design thinking approach and its connection with management

amplifies the capacity for interventions. This also allows designers to interact with a broad range of organizations and integrate multidisciplinary teams of skilled design thinkers (Brown 2009). Their ability to generate new concepts to address needs and potential opportunities, combined with business capacities for effectively putting their efforts and solutions into practice, reinforces the contributions of design for the entire chain of innovation activities.

Design skills are associated with: (a) the capacity to organize, set and solve problems (Zurlo 1999; Best 2006); (b) the ability to build scenarios of new ways of living, motivating visions through practice and design tools (Zurlo 1999; Meroni 2008; Rossi Filho et al.2009); (c) the skill for making information tangible through sketches and prototypes (Mozota 2003; Best 2006); and (d) the creative talent to conceive and test new ideas, thus choosing among the more competitive directions (Brown 2009). Indeed, its skills are also related to the Design Management perspective, as a response of individuals to the needs of their businesses (Cooper and Press 1995), which can enable design to be effectively used by companies (Gorb 1990), either at corporate level or at project level (Topalian 2003).

In this way, design can support companies, particularly in micro and small businesses, in different forms (Bruce et al. 1999). More than managing processes and product creation, design focuses on improving customer services and experiences. Likewise, design contributes to increasing company efficiency as well as defining waste reduction strategies (Mozota 2003; Best 2006). The levels in which design can work, i.e. at the strategic, tactical and/or operational level, are here explored through the pilot project development, and are mainly associated with the context of MSEs in which only a few of the aspects of design are allowed to reach their full potential.

Beyond the association of design with sustainability and policies, and in order to define strategies to connect design and innovation with a practical intervention, some characteristics of pilot projects are investigated. They are recognized as a means: (a) to develop evidence of policy innovations (Vreugdenhil and Ker Rault 2010), (b) to improve knowledge, and (c) to benefit the economy and the environment (Goedkoop et al. 1999; Manzini et al. 2001; Mont 2002). Pilot projects are described as collective trials to test innovations (Latour 1999) that enable learning platforms by exploring insights and scaling up processes (Pound et al. 2003; Van den Bosch and Rotmans 2008). As pilot projects generally adopt new approaches in limited fields, they can improve these contexts, thus contributing to adjusting management practices and policies (Vreugdenhil et al. 2010).

Notwithstanding all the difficulties pilot projects present, they have been used as applied instruments in different domains, because they configure a space to introduce and test innovations with smaller risks either on smaller geographical scales or in short times. Since failure, to some degree, is better accepted in pilot projects, participation is more likely to occur (Vreugdenhil and Ker Rault 2010). Effects of Pilot Projects are noticed when some change of structure or behavior occurs and the greater the knowledge developed within the experience, the greater

the possibility of spreading that experience (Sabatier 1988; Bergman and Coxon 2005).

Within this work, the features of the developed pilot project are a combination of research and managerial pilot projects, since it aimed at both building knowledge and dealing with local problems. Moreover, as it was intended to orient regional design policies, it can be argued that the developed pilot project is more related to institutionalization as a pattern of diffusion.

4.1.3 Knowledge at the Boundaries

For both researchers and practitioners, knowledge is recognized as a decisive factor in creating competitive success within organizations (Kogut and Zander 1992; Nonaka and Takeuchi 1995). Despite this, due to the difficulty of transferring knowledge (Szulanski 1996; Swan et al. 1999) and its tacit nature (Nonaka 1994; Von Krogh et al. 2000), increasing knowledge is still a great challenge. For Campos et al. (2003), companies are a source of knowledge and their development is determined by their own internal characteristics and by the environment in which they are inserted. For Carlile (2002), however, since knowledge in organizations is particularly problematic in new product development, it represents both a source of, and a barrier to, innovation. The author affirms that problems occur at '*knowledge boundaries*'. Since products and services of companies are based on specialization, knowledge at the boundaries is a critical challenge, but also a permanent need (Carlile 2002, 2004).

Some authors (Allen 1971; Nonaka 1994; Nonaka and Takeuchi 1995; Carlile 2002, 2004) have discussed some approaches for investigating the 'knowledge boundaries' in product development. These are mentioned as syntactic, semantic and pragmatic approaches. Carlile (2004) suggests the use of prototypes and other boundary objects to transform knowledge collectively and this approach is explored in this research.

Carlile (2002) also suggests that knowledge cannot be isolated from the individual's practices. Sharing knowledge demands more than its exchange to allow collective learning between different knowledge domains, i.e. it requires the capacity to deal with specific problems, the understanding of technologies and rules, and the investment of individuals in practice. According to Star and Griesemer (1989), boundary objects are

> objects plastic enough to adapt to local needs and the constraints of the several parties employing them, yet strong enough to maintain a common identity across sites.(…) These objects may be abstract or concrete (Star and Griesemer 1989, p. 393).

Bearing this in mind, boundary objects can help in the creation of a common basis for facilitating communication because, even if they have different meanings in different contexts, they are still recognizable enough by more than one context.

The view of boundary object approached by this study aims at creating an interface through design among partners—industries, university and government—to enable engagement and synergy for their collaboration in networks. Indeed, all elements developed (prototypes, meetings, exhibitions and the pilot project) as a process, are taken as boundary objects. Above all, the use of an element that acts at the boundaries intends to generate a new knowledge through a pragmatic learning process that raises awareness in individuals of the importance of knowledge itself and the need to assume new paths towards more efficient and sustainable scenarios.

4.1.4 Transition Towards a Sustainable Co-production Value

The The dimension of sustainability has over time included aspects of social concerns, technology and culture to approach the whole-system that constitutes contemporary society (Gilman 1990; Manzini 2006; Redclift 2006). In this spectrum, a deeper awareness of the value of interconnections, cooperation and collaboration, results and response cycles is necessary in order to include as many actors as possible to face the problems.

To be improved, the transition from one socio-technological system level to another demands breaking away from daily practices performed by individuals, groups, business organizations, policy makers and society as a whole, as well as a renewal of institutional behavior (Gilman 1990). This confirms the importance of a learning process that helps change, by defining problems, assumptions, regulations and frames that orient decision-making processes as actions for individuals, organizations and society.

Among several principles discussed by the Agenda 21, in 1992, the transition towards sustainability already included many issues.[1] Nevertheless, such a transition is still very complex because it depends on the ample participation of each member of the entire social system, i.e. companies and consumers, institutions and researchers, government, media and NGOs, just to mention a few (Tischner 2010). The presence of leaders and their operations in strategic partnerships is thus a vital effort to move processes and to generate positive side effects. From a company's perspective, competitive advantages demand the creation of innovations that, beyond sustainability concerns, also contribute to the engagement of people and to the local development of a specific context (Gilman 1990; Hall 1995).

From the viewpoint of design, design for sustainability is a strategic approach that favors the attainment of environmental stewardship, economic growth and

[1]These include environmental protection, social development, survival of future generations, diversity, community engagement in policy issues, balance between production and consumption patterns to reduce unsustainable impacts, and cooperation, to improve scientific and technological skills and increase the diffusion of innovative technologies (United Nations, 1993).

social progress. Designers are then asked to broaden their references to potentiate their activities, therefore including as partners institutions, associations, service providers and other groups as well as business organizations. In addition, it is fundamental to adopt a new design paradigm to operate production and consumption processes (Morelli 2007).

Among the working habits designers must have, Tischner (2010) highlights some: (a) to analyze possible social and environmental problems using available tools; (b) to analyze preliminary conditions of clients/companies to identify alliances in the sustainability of the design process; (c) to seek social-environmental-economic benefits (Elkington 1994); (d) to learn about drivers for sustainable solutions; and (e) to try to involve users of the innovation process in order to understand their motivation to change behavior and their preferences on sustainable offers.

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Chapter 5
Inter-organizational Collaborative Network (ICoN) Model

Abstract This chapter presents the conceptual Inter-organizational Collaborative Network (ICoN) model developed within the research to guide the proposition of such a network in the local context of the intervention. The ICoN model was aimed at defining the most important relationships among participants of the network proposed, their roles and their pattern of relations, during a defined long-term project or a planned task. The chapter discusses the theoretical references adopted to build such a model, such as: the Triple Helix concept, aspects of collaboration and innovation within networks through Design, as well as the importance of using the Design management view when managing Pilot projects and, finally, the role of Boundary objects as a bridge to knowledge and innovation.

Keywords Inter-organizational Collaborative Network Model · Triple helix concepts · Strategic and sustainable solutions through *ICoNs*

As discussed, collaboration is commonly pointed out as a valuable way to encourage learning (Brna 1998), a platform for improving services and sharing resources (Kloth and Applegate 2004) as well as pursuing collective outcomes (Jansen et al. 2008; Hocevar et al. 2011). Building on the work of some authors (Roschelle and Teasley 1995; Burton et al. 1997), Brna (1998) sets some significant aspects of the matter: (a) division of labor (e.g. a task divided into parts or involving simultaneous efforts with no division of itself); (b) collaboration as a State (i.e. a collective effort) and as a Process (i.e. cooperative but divided tasks) (Brna 1998); (c) purpose (i.e. collaboration is the means to an end for learning about some particular field, or it is the end itself) (Burton et al. 1997; Brna and Burton 1997); and (d) implicit obligations (often present in collaborative processes, whether or not participants are aware of them) (Brna 1998).

In knowledge-based economy, the key role of collaboration among university, industry and government for innovation and growth has been discussed by many authors (Etzkowitz and Leydesdorff 1998; Etzkowitz et al. 2000; Etzkowitz 2008; Leydesdorff 2012). The Triple Helix, as it is defined, has led to the venture capital

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firm, the incubator and the science park. In such interactions, even if the institutions maintain their primary roles and distinct identities, each of them is supposed to assume new tasks (Etzkowitz 2008). In different countries, the Triple Helix concept has also been adopted as an operational strategy for regional development and to favor knowledge-based economy, as in the case of Sweden and Ethiopia (Etzkowitz 2008). In Brazil, for Almeida (2005), the Triple Helix became an effort for the production of incubators in the university context.

5.1 Positive Implications of Collaboration

For Brezet and Ehrenfeld (2001), collaborative patterns of interactions come from the awareness of complexity in the contemporary context. These patterns relate to the demands of customized solutions as well as the specialization of companies through knowledge acquisition, which requires external resources. Paula (2004) stresses that positive externalities coming from proximity, cooperation and organization of MSEs in a territory are a strong factor of local development. Such aspects shape a favorable environment necessary to provide sustainability and competitiveness for companies (Paula 2004).

University (as an institution) assumes, therefore, the generative condition, while the government and industry were the primary institutions in industrial society. Etzkowitz (2008) argues that industry maintains its key role as the locus of production, as well as the government remains the source of regulatory activities to assure the stability of interactions and exchange. In general, the triple helix model starts from a reciprocal relationship among university, industry and government, in which each of them attempts to improve the performance of the other. Such initiatives mostly take place at the regional level, where specific contexts of industrial clusters, academic development and presence or lack of governing authority influence the development of the triple helix (Etzkowitz 2008).

The first step towards this model involves the collaboration among the institutional parts most involved with innovation. For example, the three spheres of a region engage in discussions with the aim of enhancing the local economy, developing a regional growth agreement or establishing a technology council, thus assuming collaborative and interdependent tasks to support a shared goal. At this initial level, they usually focus on enhancing the performance of existing industry in order to improve the local economy.

The conceptual ICoN Model amplifies the Triple Helix model, in order to allow the "visualization" of the interconnections among the diverse actors, with different roles and skills. The ICoN model comprises, thus, other types of actors that could collaborate to provide more effective outcomes to those involved, including environment and society. According to the model proposed in this research, relationships have mainly interdependent operations to make the system function as a

whole, even though individual actions exist. Based on several authors, the intent of such integrating ICoN is associated with many positive reasons:

- in the case of partners such as university, support, research and funding institutions and government, collaboration is usually motivated by: (a) the interest in developing new knowledge or in stimulating and testing innovations, or both (Tomael et al. 2005; Tsai 2009; Pertuzé et al. 2010; Vreugdenhil and Ker Rault 2010); (b) the need to communicate between actors that usually do not collaborate (Gupta, et al. 2000; Kloth and Applegate 2004); or (c) the reduction of environmental impacts that come with unsustainable practices and production processes (Hall 1995). The competitive advantage of university, in comparison to other knowledge-based institutions (e.g. R&D units of companies and government laboratories), mainly regards the continuous flux of students who continually bring new ideas, in a "flow-through of human capital" (Etzkowitz 2008).
- to business organizations, the goal is typically to: (a) increase skills, productive capacities (Swan et al. 1999) and co-production value (Ramirez 1999); (b) reduce uncertainties in internal structures and in external environments (Van de Ven 1986); (c) acquire competitive advantages, thus upgrading position in the market place; (d) gain future business opportunities (Todeva and Knoke 2005; Teixeira 2005); or (e) comply with specific requirements of environmental and sustainability changes (Elkington 1994; Manzini and Vezzoli 2002; Vezzoli 2007).
- to community associations and/or NGOs, the notion of working collaboratively is, most times, intrinsically related to the improvement of social conditions among the groups assisted by such entities. Thus, it is expected that any collaborative proposal must include in its scope the possibility of generating income resources, besides helping to minimize problems with quality of life and health.

5.2 The ICoN Structure and Relationships

The proposed ICoN model (Fig. 5.1) considers that relationships are more or less intense, depending on the participants' profiles. Some issues are associated with their background, potential for pro-activeness, capacity for communication, cohesion of and commitment with, interest in common goals and continuity of actions.

Therefore, relationships must be established with the aim of achieving the best possible level of effective participation, to achieve higher positive impacts. Concerning their characteristics, according to the model, these relations are interpreted as:

- *Continuous and direct relationships* (represented by continuous lines): are those in which the parties work in collaboration side-by-side during the whole development of a long-term project or planned program. The constant support to the activities contributes to intensifying knowledge-sharing, commitment and trust as well as the continuity of actions. They include relationships with funding

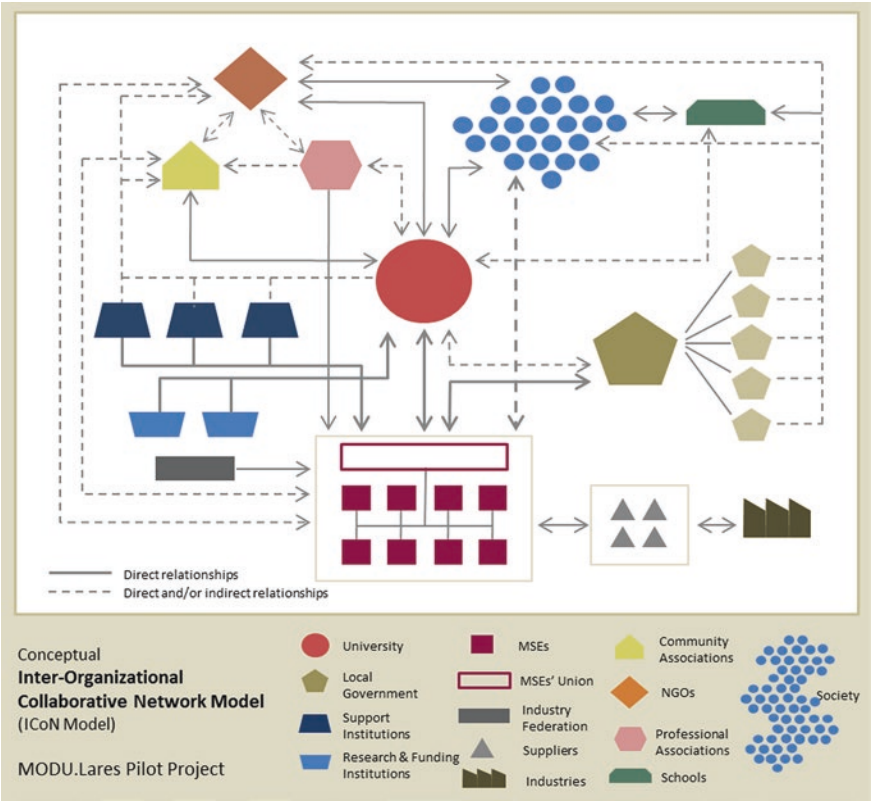

Fig. 5.1 *Conceptual ICoN Model,* according to Nunes (2013)

institutions with an interdependence of actions and pledges with positive results, despite no direct contact is observed;

- *Intermittent and direct or indirect relationships* (represented by dashed lines): are those in which the parties collaborate to reach a common goal, defined by the same long-term project or planned program. In this case, however, some tasks towards a common goal are individual. While the relations are interdependent, the contacts (direct or indirect) with these partners occur in previously planned periods to verify results of work-in-progress as well as to communicate with the entire collaborative network. These meetings and exchange of information will reinforce trust, thus getting insights into continuous working in collaboration.

5.2.1 Actors Involved in the ICoN Model

Considering the above, to be effective (in terms of benefiting the group of actors involved) the ICoN model considered the integration of (and the roles for) the actors listed below:

5.2.1.1 University

University (as an institution) is the central point of the network, to work as an element for gathering and coordinating the different partners and actions. Moreover, such a partner is responsible for sharing knowledge, developing innovative proposals and supporting their deployment in partnership with the other organizations involved. Its integration aims at solving highly contextualized problems or at exploring opportunities, as well as achieving a greater level of sustainability in a given reality.

5.2.1.2 Support Institutions

The Support Institutions are responsible for providing technical and operational opportunities, e.g. skilled labor, training courses and well-focused consultancies. They work in coordination with a broad objective of the long-term proposals, in a contextualized manner, having in mind the time needed to reach effective learning and to adopt better practices. Since MSE investments and social entities are frequently at risk due to lack of funds and of time, whenever possible, these institutions may provide them with economic support, thus creating conditions to facilitate their participation in the initiatives.

5.2.1.3 Research and Funding Institutions (R&F)

Research and Funding Institutions are mainly responsible for providing the means for research and development of new solutions in products, processes and services. Even their direct contact in such a collaborative network is more feasible to occur through a university rather than between them and the MSEs. Intermittent relationships between MSEs and R&F institutions are not fully eliminated, but assisted by university.

5.2.1.4 Local Government

As the partner which operates with regulatory activities, the Local Government is responsible for creating and implementing policies as instruments of development for a given region, through its various sectorial departments. As an example, the departments can include sectors such as social and economic development,

environmental control, education, culture and housing. The integration of this actor in such an ICoN has the aim of fostering policies and actions that operate in coordination with the global scope of a long-term project.

5.2.1.5 Micro and Small Enterprises (MSEs)

As a productive sector, MSEs are responsible for the generation of solutions represented by products or services, or by product-service systems. Allowing for their various operating deficiencies, their integration in a collaborative network intends to strengthen potential operations. This comprises advantages from sharing knowledge, equipment, investments, thus improving managerial issues. It aims at increasing sustainability awareness and the value of co-production. MSEs are expected to establish interdependent actions with social organizations, NGOs and with society, as they are viewed as customers but also as partners. The attention to sustainable and tangible offers contributes to intensifying the quality of life and the practices that can minimize environmental impacts and contribute to a healthier society.

5.2.1.6 Suppliers (Retailers and Wholesalers)

Suppliers are those responsible for providing a wide range of materials, components and accessories necessary to MSE operations. Their integration in the network is related not just to their role in providing responsibly-sourced and certified materials to assure lower environmental impact. Indeed, a significant contribution is also to act in collaboration with MSEs by supporting them with services towards the final correct disposal of toxic materials (e.g. reversal logistics).

5.2.1.7 Community Associations and NGOs

Community Associations and NGOs are entities which usually work directly with the community to solve social problems, with different focuses. Their relevant integration in such a network is due to the support each partner can provide to organizations, helping them to assist specific groups, in a broader long-term project. Support is given by either increasing the social entities' knowledge or creating opportunities for increasing income and, hence, providing them with the means to work.

5.2.1.8 Professional Associations

Members of Professional Associations can contribute to the formation of members of community associations or NGOs with their skilled knowledge. Besides increasing the relevance of their work—while assuming a social role—professionals can have the opportunity to improve their knowledge through contact with the

university and business organizations, thus learning new ways of working towards sustainability.

5.2.1.9 Schools

Schools are a type of organization which works directly with the formation of human capital. Their integration represents an opportunity to develop from an early age the awareness of social problems and environment as well as of entrepreneurship, collaboration and creative solutions through design, which could contribute to minimizing problems in the future. Even though not directly connected with all organizations, schools can be part of long-term programs, also supporting the construction of knowledge in groups assisted by community associations and NGOs.

5.2.1.10 Society

Society is, simultaneously, a broad actor and a beneficiary of more responsible actions. Society is not an organization *in se*, but an organism with constant needs. Integrating it in such an ICoN aims at including the population demands when developing any kind of project and long-term proposals in particular. As an example, this integration can be related to the definition of a new specific product to satisfy the needs of the low income population as well as to propose services that demand a wide public participation to become efficient and succeed.

5.2.2 Achieving Sustainable Solutions Through ICoNs

In a whole-system approach, a sustainable system refers to networks that include people, services and infrastructures which exist and co-operate in a sustainable way. This systemic view necessarily includes different types of social and economic actors and requires their collaboration to improve behavior and quality of interactions in order to develop effective sustainable solutions. With respect to this, two main arguments build possible scenarios of sustainability:

- *Concerning relationships:* on the whole, a sustainable system must integrate environment, technology and individuals while respecting the ethical values that regard people and society, the relationship with "Nature" and the environment and social, economic and technological issues (Elkington 1994; Sachs 2002; Redclift 2003; Manzini 2006). In order to attain its higher degree of quality, the local context must also incorporate a variety of social, cultural and economic parameters that allow to measure the achievement of people's needs (Elkington 1994; Manzini and Vezzoli 2002; Manzini 2006).
- *Concerning the systems of production and consumption*: the environmental dimension is related to the use of the inherent potential in the various

ecosystems, consistent with their minimal deterioration, which involves the preservation of energy sources and natural resources (Elkington 1994; Sachs 1993, 2002). The design system must be eco-efficient, to minimize the consumption of resources and materials, prioritize low impact processes and the adoption of safe raw material (Manzini and Vezzoli 2002; Ljungberg 2005; Vezzoli 2007).

Since viable solutions to problems of resources and capabilities are not often available within a single company (and most times, they are difficult to obtain efficiently in the market) (Das and Teng 2000), ICoNs are a relevant instrument for enhancing the companies' skills towards innovative and sustainable solutions. Tsai (2009) argues that collaborating with different types of partners represents the diversity of knowledge networks, amplifies comprehension of the wide range of options for intervention and increases the probability of achieving innovation because of the variety of knowledge shared. For this reason, organizations must observe external resources and also restrictions through collaboration as a means of complementing and influencing their internal development capabilities (Tsai 2009).

5.3 Innovation Within *ICoNs* Through Design

For Etzkowitz (2008), when institutions assume the role of another, due to an internal transformation, the triple helix is developing towards a second level of innovation. The innovative contribution of these interactions is to combine the core competency of an institution with the secondary activity of another institution to perform this role. In this way, each actor is more likely to become a creative source of innovation and to support the creativity that emerges in other spheres. This is also expected to occur within ICoN environments, but respecting the specificities of tasks.

In the specific case of Design, its value has been discussed as a vital strategy and an innovative resource for companies and their businesses to translate the needs of society into real solutions in different fields (Dell'Era et al. 2010). For Manzini and Vezzoli (2002) and Vezzoli (2007), designers have to deeply engage in interconnected networks, where individuals, companies, local and global institutions use creativity and partnerships to solve problems as well as to trigger the change towards sustainability. However, the effectiveness of solutions will depend on interrelated factors, especially ones related to the ability of designers to enhance and guide them by proposing tangible steps towards strategic and systemic sustainable directions, inside organizations, businesses or academic contexts (Gilman 1990; Manzini 2006).

5.3.1 The Role of Design

The drivers for innovation have been discussed with different focuses. Drivers related to the environment, technology, education, social needs, economy and

market depend on the context and the field in which they are explored. For Dearing (2001) and Nidumolu et al. (2009), sustainability is the key driver for innovation because only companies that assume it as a goal can really achieve a competitive advantage. Based on the same notion, Yoon and Tello (2009) explore some drivers for sustainable innovations such as consumer demand, CSR initiatives, government intervention, social activism and technological advance.

For some authors, Design is the most promising driver for applying technological innovations (Chen et al. 2010), social innovations (Manzini 2007; Morelli 2007; Chen et al. 2010), and 'meaningful innovations' (Verganti 2008; Bucolo and Matthews 2010) because more than solving problems, design favors a process to channel creativity and foster innovation with specific aims. The Design process is described by Brown (2008) as a system of spaces, i.e. interrelated activities rather than a predefined series of logical steps, which form the continuum of innovation or an "inspiration, ideation and implementation" cycle. However, creativity must be combined with other aspects to best explore the potential of new ideas.[1]

Innovation practice in design is not only strictly connected to creative processes, but also to design management. Several authors (Van de Ven 1986; Zurlo 1999; Mozota 2003; Best 2006; Manzini 2007; Owen 2007; Brown 2008) argue that a crucial issue to achieve innovation is to establish a multi-disciplinary team, which permits the sharing of experiences and objectives. At this point, innovation is no longer associated with physical products. It includes types of processes, services, IT-powered interactions, entertainment and ways of communicating and collaborating. These are precisely the kinds of human-centered activities in which design thinking can make a decisive difference (Raulik-Murphy 2010).

5.3.2 Design Management Perspective

The importance of Design Management for the deployment of design within a company has been discussed by Gorb (1990), Cooper and Press (1995), Mozota (2003), Topalian (2003), Hollins (2004), Best (2006), among other authors. Their varied perspectives reflect the vast group of individuals, professions and contexts involved in it, such as university, public or private sectors, business and industry, the design profession, public or governmental bodies. Design Management has a leading role, requiring explanation, inspiration, persuasion and demonstration of how design can definitely contribute to an organization in many different ways (Bruce et al. 1999). In the wide-ranging context of an ongoing change, its focus is also on improving customer services and experiences and on increasing efficiency and waste reduction strategies (Mozota 2003; Best 2006).

[1]Owen (2007) and Brown (2008) set some design skills to strengthen the innovation outcomes: (a) capacity for adaptation; (b) integrative thinking; (c) experimentalism; (d) collaboration; (e) human and environmental concerns, and (f) multi-functionality and systemic vision.

For Mozota (2003) and Best (2006), within an organization, design is considered a function, a resource and a way of thinking, and can operate in strategic thinking, in developing processes and especially in implementing projects, systems and services. Moreover, Design can either work at operational, tactical or strategic levels, in setting long-term goals and in daily decision-making (Mozota 2003; Best 2006). Best (2006) still indicates three different stages in managing design as a strategy: (a) first stage: design projects and initiatives are conceived; (b) second stage: design projects and agendas are developed; and (c) third stage: design projects and outcomes are delivered.

As design is deeply linked to business, it is undoubtedly a strategic resource to companies, both adding and creating value for them and a sort of competitive advantage (Mozota 2003; Zurlo 2012). Its key role is noticed when influencing the world and creating new products, systems and services in response to large market conditions and opportunities. Additionally, by using such strategic capacities, design is increasingly assisting the development of social, ecological, technological and cultural processes as well as the evolvement of organizations in different sectors (Manzini and Vezzoli 2002; Mozota 2003; Best 2006; Manzini 2006; Morelli 2007).

5.3.3 Pilot Projects as Strategy to Foster Innovation

In the context of innovations, pilot projects are recognized as strategic tools to develop evidence of policy innovations (Vreugdenhil and Ker Rault 2010), to improve knowledge as well as to produce economic benefits and reduce environmental problems (Goedkoop et al. 1999; Manzini et al. 2001; Mont 2002). They are also considered collective trials to test the technical and socio-political configuration of an innovation (Latour 1999), which can enable learning platforms for the development of new insights from lessons learnt and the measurement of the intervention (Pahl-Whostl 2006; Loorbach 2007), and to scale up processes (Pound et al. 2003; Van den Bosch and Rotmans 2008).

For Vreugdenhil et al. (2010), pilot projects are the means of applying new approaches in a limited field setting, to learn about the innovation context interaction and to use these lessons for its improvement or for adjusting management practices and policies. Pilot projects can be designed to serve multiple functions also in transition management, which makes them an attractive instrument for diverse social problems and contexts (Loorbach 2007).

The relevance of pilot projects has increased as a result of the complexity of both contemporary society and technology and of policy-making (Cabinet-Office 1999). The scarce confidence in some professions and public organizations and the requirement of governments to find out whether policies do or do not work as intended (Solesbury 2001; Cabinet-Office 2003), create favorable conditions for the development of pilot projects. For researchers these experiments provide a tool to improve innovations, cooperate with societal actors and to collect financial resources. Practitioners can find out whether certain innovations make

management more efficient and are thus worth being applied at a larger scale (Snapp and Heong 2003; Van den Bosch and Rotmans 2008; Vreugdenhil and Ker Rault 2010).

Vreugdenhil et al. (2010) identify three types of pilot projects: (a) research pilots are mainly oriented towards the development of knowledge on the innovation tested (Solesbury 2001; Vreugdenhil and Ker Rault 2010); (b) managerial pilot projects start from a pragmatic point of view and are proposed to solve a local problem for which no standard solutions already exist, or to implement a totally developed policy program (Vreugdenhil and Ker Rault 2010); (c) political-entrepreneurial pilot projects are those initiated for particular interests by entrepreneurs, who can come from politics, commercial businesses or even research institutes (Vreugdenhil et al. 2010).

Within this research, the characteristics of the developed pilot project are a combination of research and managerial pilot projects, since it aimed at building knowledge but also at dealing with local problems. Moreover, as it was intended to orient regional design policies, it can be argued that the developed pilot project is more related to institutionalization as a pattern of diffusion.

5.4 Boundary Objects as a Bridge to Knowledge and Innovation

In the last two decades, knowledge in organizations has received great attention. For both researchers and practitioners, much of this interest comes from the recognition that knowledge is a decisive factor in creating competitive success over time (Kogut and Zander 1992; Nonaka and Takeuchi 1995). However, this awareness is still a noteworthy challenge, due to the difficulty of transferring knowledge (Szulanski 1996; Swan et al. 1999) and its tacit nature (Nonaka 1994; Von Krogh et al. 2000).

The authors above have been explaining why knowledge is difficult to manage (Carlile 2002). In actual organizations, there is an effort to explain the reason knowledge continues to be a crucial but challenging source of competitive advantage for them. Starting with the premise that knowledge in organizations is problematic, particularly in new product development, this represents both a source of, and a barrier to, innovation. The characteristics that push innovative problem solving *within* a function in fact delay problem solving and knowledge creation *across* functions (Carlile 2002).

5.4.1 Working at the Boundaries

According to Campos et al. (2003), companies are a repository of knowledge and their development is determined on the one hand, by their own internal

characteristics, which define specific processes of knowledge and their skills and, on the other, by the environment in which the company is inserted, in relation to the technology, the production structure, the competition pattern and the social context. These companies obtain competitive advantages from the dynamic capabilities (Teece and Pisano 1994) developed in their routine, hence creating important elements such as values, culture, abilities and organizational experiences built in cumulative and path-dependent processes.

Additionally, Carlile (2002, 2004) affirms that problems are found at these 'knowledge boundaries' and that they are not only a critical challenge, but also a permanent need, since the products and services of the organizations are, most times, based on the specialization of different kinds of knowledge. When investigating the 'knowledge boundaries' in product development, Carlile (2002) discusses two approaches: (a) the Syntactic approach, where a "common syntax" ensures precise communication between parts across a boundary and solves challenging communication or information processing problems; and (b) the Semantic approach, in which even if a shared syntax or language exists, interpretations are often different, which can hamper communication and collaboration. The creation of common meanings always requires translating knowledge (Carlile 2002, 2004).

Carlile (2002) also proposes a third complementary approach defined as the Pragmatic approach. Within the empirical focus, knowledge is adapted to obtain a particular result, thus common practices are developed to transform knowledge and interests, and provide proper means to share and assess knowledge at a boundary (Carlile 2004). The author suggests the use of prototypes and other kinds of boundary objects that can be collectively transformed. The creation of common interests demands a relevant practical and political effort (Carlile 2004).

5.4.1.1 Effective Boundary Objects

Boundary objects acting at the interface of knowledge fields provide a shared syntax which allows the exploration of semantic differences and helps the mutual transformation of knowledge between practice communities (Carlile 2004). For Carlile (2002) three characteristics of a tool, method or object make boundary objects valuable to aid problem solving at a given boundary:

- at a syntactical level, a boundary object creates a common "language" for individuals to represent their knowledge and manage it at a boundary;
- at a semantic boundary, an object provides a concrete method that allows individuals to establish and learn about differences and dependencies across a given boundary, and helps to address assembly and testing issues[2];
- at a pragmatic boundary, an effective boundary object simplifies a process where individuals can reciprocally transform their knowledge.

[2]The adoption of physical prototypes in cross-functional problem-solving valorizes the concrete object in relating parts, but also in understanding the dependencies between them.

If negative results are identified, individuals must be committed to modifying, negotiating or shifting the object or representation used. Individuals must be able to transform the existing knowledge into new knowledge in order to impact positively on a product's development.

The importance of sharing knowledge is directly associated to the necessity to transform knowledge at a boundary, in specific contexts, in order to solve problems and overcome undesirable negative results. Consequently, the notion of a boundary object adopted within this research aimed at creating a common language through design among participants, in order to facilitate engagement and synergy for their collaboration in networks. Above all, the use of a boundary object also intended to create new knowledge, from its transformation by interacting and practicing, i.e. in a pragmatic learning process, in order for one to become aware of the crucial need of a behavioral change that regards innovation and sustainability.

5.5 Transition Towards Sustainability

Some decades of investigation made conceptual advances in sustainability possible, broadening scientific knowledge on the biosphere and the imminent risks, and brought progress by institutionalizing concern related to environmental management. Consideration of the whole context of human-environment is the key to establish more sustainable behaviors, policies and outcomes (Gilman 1990; Elkington 1994).

In consequence, transition from one socio-technical system to another should be considered as a process that requires breaking away from routine performances of individuals, groups, business communities, policy makers and society in general, which means the replacement of old institutions with new ones. More specifically, it is a crucial new paradigm of thinking and acting that requires a learning process, that contributes to changing the problem definition, the basic assumptions, norms, values and frames which orient the decision-making processes and actions of individuals, organizations and society (Brown et al. 2003).

5.5.1 Sustainable Production and Consumption Systems

The sustainable path involves people acting in the background as silent leaders and operating through strategic partnerships. Such efforts contribute to setting in motion processes that have favorable system-wide effects. However, putting innovation into broad practice and communicating with a much broader public, as a way to increase awareness of environmental and social problems, is highly necessary (Gilman 1990; Hall 1995). For some authors, a new design of human institutions, especially in economics and governance, including design education, is

essential. This is due to their capacity to influence a satisfying and environmentally healthy life quality, and to create sustainable solutions and managing their implementation processes (Gilman 1990; Hall 1995; Morelli 2007).

From the viewpoint of designers, design for sustainability is a strategic approach to conceive and develop sustainable solutions in order to achieve three central levels: economic growth, environmental stewardship and social progress. This will contribute to improving life quality and renewing social contexts (Elkington 1994; Manzini 2006; Morelli 2007; Tischner 2010). If traditional industrial production is moving towards more damaging models of globalization, the operational strategies of global companies are forcing them to pay more attention to local contexts.

Therefore, competitive advantages for companies entail the creation of innovations now focusing on the local level and on individual people. Customers are no longer passive receivers of products, but active co-producers of their own values. This condition requires a new interpretation of the relationship between industry and customers, which orients towards a new logic and also demands a new approach to social problems that strengthens social and individual skills (Morelli 2007).

The designers' capacity to offer innovative alternatives, working together with companies is a crucial skill for the realization and delivery of these solutions (Manzini 2007; Morelli 2007; Castro and Carraro 2008; Brown 2008). Two conditions to address a new design agenda toward sustainable scenarios are, however, mentioned by Morelli (2007):

- Designers must enlarge their references for their new potential activities in the local context, thus including local institutions, associations, service providers, local groups and individuals;
- As social problems are complex and urgent, and often emerge in places not covered by market-driven policies, it is crucial to adopt a new paradigm of design to operate production and consumption processes.

Hence, designers must assume some precise attitudes to facilitate production and consumption, consequently leading to solving problems and changing patterns towards more sustainable systems (Tischner 2010). As set by the author, designers must: (a) analyze all possible social and environmental problems of the current system and solutions, in a given time and scope; (b) analyze the preliminary conditions of the client or company and use existing initiatives to identify alliances in the Sustainability Design process; (c) seek the most radical Social-Environmental-Economic benefits (Elkington 1994), thus allowing clients to manage the supply and value chain flows; (d) be aware, learn about and adopt drivers for sustainable solutions; and (e) involve real users as much as possible in the innovation process and know what motivates their behavior change towards a more sustainable direction and what characteristics of sustainable offers they would appreciate and enjoy (Tischner 2010).

At local level, the design process assisting the complex systems of interactions could support knowledge-sharing between those involved, i.e. designers,

companies, institutions and government as well, in order to transform the initial knowledge into a platform of new knowledge to support a set of effective systemic and sustainable design solutions to address individual needs. These solution platforms must combine different skills and precise design roles towards planning innovative interactions, with a balance between what is technologically possible, socially desired and economically viable (Morelli 2007; Meroni 2008; Tischner 2010).

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Chapter 6
Design and the Furniture Industry in Brazil

Abstract This chapter brings an historical panorama of Design and the Furniture Industry in Brazil as well as a brief description of the highly fragmented Design System in the country. Issues related to the competitiveness as well as design management and sustainability aspects are discussed in this chapter in order to understand the huge Managementchallenges faced by the Brazilian Furniture industry, mainly those associated with industries that do not integrate furniture cluster. This chapter intends to provide a broad vision of the context of the intervention.

Keywords Wooden furniture industry in Brazil · Brazilian design system · Design policies and programs in Brazil

6.1 A Historical Overview

The recognition of design as a professional activity in Brazil only occurred in the 1950s, with the opening of the Contemporary Art Institute (IAC) of the Art Museum and the creation of the Superior School of Industrial Design (ESDI) in 1963 (Cardoso 2005). Events such as the construction of Brasilia, the *Mole* Armchair Award by Sergio Rodrigues (in 1961), new furniture concepts from Lúcio Costa and Oscar Niemeyer, contributed to the emergence of Brazilian brands and design icons in the following years.

At the same time, after the Second World War, with the interruption of imports and the arrival of famous Europeans, some facts contributed to the first sign of the industry, including furniture production. Architects, artists and artisans wanted to develop modern furniture with an aesthetic cleanliness and simplicity of construction that would make industrialization possible with a Brazilian identity (Santos 1995; Leon 2005).

The 60s and 70s were fruitful decades for design promotion: the Brazilian Association of Industrial Design (ABDI) was created in 1963 and the International Design Biennials in Rio de Janeiro were held in 1968, 1970 and 1972. There was, however, an evident gap between the pioneer designers and the furniture industry

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(Leon 2005, 2009). The first center of industrial design (NDI) emerged in 1975, proposed by the Federation of Industries in São Paulo, to disseminate design among companies (CSPD 2012).

Although the 1980s highlighted a new generation of innovative furniture designers, who explored flexible solutions for contemporary homes, production was still limited to small series or artisanal productions, and mainly associated with 'authorial design' (Santos 1995). Industry-oriented R&D design was still in its early stages (Barroso Neto 1998). The first research initiative oriented to industrial design and product development was observed only in the middle of the 1980s. The aim was to decentralize federal actions and stimulate the execution of priority projects for a design program in Brazil. Thus, the Brazilian Council of Technological and Scientific Development (CNPq) supported the creation of three Laboratories for Product Development/Industrial Design (LBDI): in the South (Florianópolis/SC), the Southeast (São Carlos/SP) and the Northeast (Campina Grande/RN). Associated with the technological center of the UFSC (Federal University of Santa Catarina), this LBDI became an important research institute for product design in Latin America, developing activities such as services to the industry, training and research in design. It was closed in 1997 (Barroso Neto 1998).

The 1990s were a difficult political period marked by economic stagnation and the failure of economic plans. Despite law reforms, the governmental economic policies introduced in the post-military-regime did not succeed in stopping inflation. However, Averbug (1999) affirms that such policies helped to remove restrictions on companies, increasing their competition by reducing taxes and privatizing public enterprises, as well as raising productivity by modernizing the industry. This allowed national industries to face the global market and they had to seek commercial advantage for their products (Averbug 1999; Raulik-Murphy et al. 2008).

The 90s and 2000s in Brazil witnessed the emergence of many young designers who worked with furniture (particularly in wood) and also contributed to introducing contemporary concepts to furniture solutions. Among them are Claudia Moreira Salles, Fernando Jaeger, Luciana Martins and Gerson de Oliveira, Aristeu Pires, Fernando and Humberto Campana, Isay Weinfeld. Their creation was, however, still predominantly associated with 'authorial design', with limited pieces mostly oriented to a higher economic class. In any case, this has contributed to spreading Brazilian design both in the domestic market and abroad.

6.2 The Brazilian Design System

A map elaborated by Raulik-Murphy et al. (2008) and Raulik-Murphy (2010) shows the structure of the Design System in Brazil (Fig. 6.1). Formed by a large and diversified number of initiatives, mainly with a short-term life, the system is not enough to make companies aware of the value of design and to prove its applied benefits. In addition to this, funding for design initiatives does not come from government sources. Large private or non-profit organizations and industry

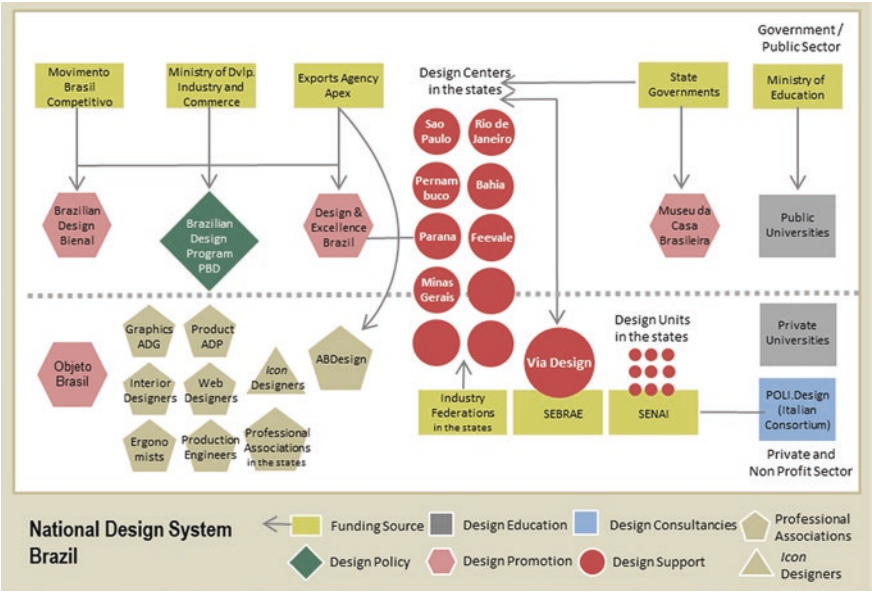

Fig. 6.1 Scheme of the Brazilian design system, built upon (Raulik-Murphy 2010)

federations frequently provide a great part of the investments in design (Raulik-Murphy et al. 2008; Raulik-Murphy 2010). In the case of MSEs, the lack of knowledge regarding design issues, procedures for requesting funding and many other internal management problems severely restrict access to investments or funding.

All the above reveals a highly fragmented design system in Brazil, which strongly affects the industrial competitiveness of the country. The Global Competitiveness Index (GCI) of the World Economic Forum 2006–2007, which included 125 countries around the world, ranked Brazil in the 66th position, at the efficiency-driven stage. At this stage, policies should aim at developing more efficient production processes and at increasing product quality. For Lopez-Claros et al. (2006), these aims could be achieved by targeting the improvement of higher education and training, market efficiency and the use of current technologies to strengthen competitiveness in a large domestic or foreign market.

Six years later, the GCI 2012–2013 (that included 144 countries) showed an improvement of Brazil, up from the 66th to the 48th position, thus reaching the Transition Level, between Stage 2 (efficiency-driven economy) and Stage 3 (innovation-driven economy) of competitiveness (Fig. 6.2) (Schwab and Sala-i-Martín 2012).

However, Brazil still presents under-performance in innovation, partly due to scarce R&D investment (Raulik-Murphy et al. 2008), and partly due to the short-term initiatives of joint projects that effectively impact the industry's performance. At Stage 3, companies must be able to compete by producing new and different

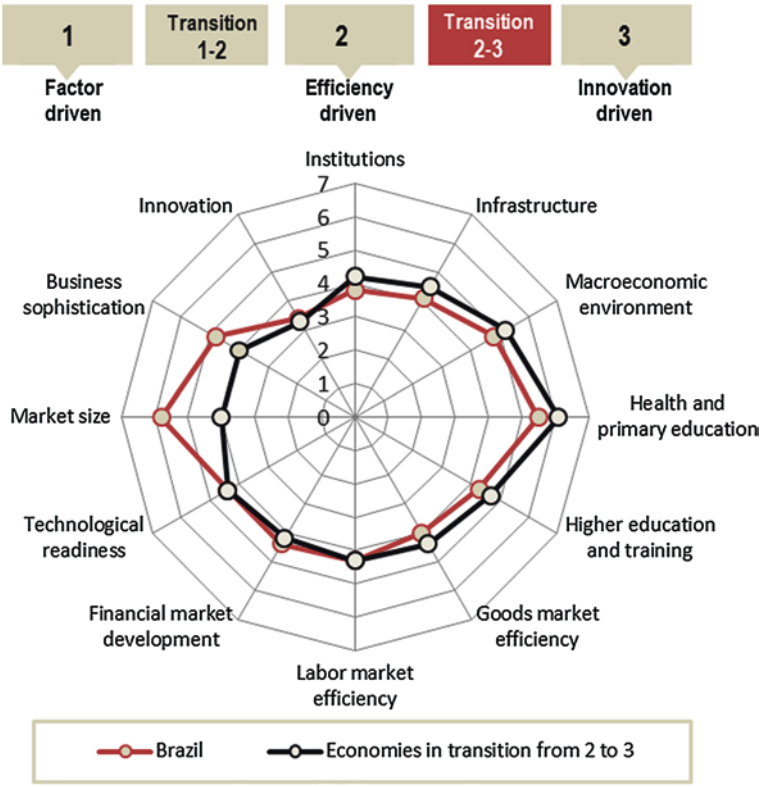

Fig. 6.2 Brazil: stage of development of GCI Global Competitiveness Index (GCI) 2012–2013 (Schwab and Sala-i-Martín 2012)

goods through new technologies and/or the most sophisticated production processes or business models (Schwab and Sala-i-Martín 2012).[1] Although some evolution has been noticed in specific areas, the integration of innovation and technology with design still remains very weak in Brazilian policy and, hence, in its industry.

[1]In 2012, Brazil attained the 48th place based on a relative improvement in its macroeconomic condition (despite inflation rate at nearly 7 %) and the increase in the use of ICT (54th). Even though some potentials are recognized, there are relevant challenges, such as trust in politicians (121st), government efficiency (111th) as well as excessive government regulation (144th). The quality of transport infrastructure (79th) remains a long-standing challenge and the quality of education (116th) does not match the increasing need for a skilled labor force. Also, despite increasing efforts to facilitate entrepreneurship, particularly for MSEs, the procedures and time to start a business remain among the highest in the sample (130th and 139th, respectively) and taxation is too high, with distorting effects (144th) (Schwab and Sala-i-Martín 2012).

The relevant investment in education—desirable from the stage of an efficiency-driven economy, that is, the stage before Brazil's current classification—has not occurred either in primary education nor in specific training programs to provide skilled labor resources. Moreover, the absence of a coordinated dialog between government entities that deal with Innovation and R&D (i.e. the Science, Technology and Innovation Ministry) and Design (i.e. the Development, Industry and Foreign Trade Ministry), even if mainly oriented to large companies, undoubtedly limits design initiatives. There are constraints on the focus for policy development, particularly those oriented to the furniture sector in Brazil.

In addition to all the problems mentioned, the performance of Brazilian design programs is also jeopardized by problems in the majority of the country's institutions, such as red tape and bureaucracy, which represents an intrinsic problem for Brazilian growth. These aspects have a negative impact on business investments and on the implementation of design programs (Lopez-Claros et al. 2006; Raulik-Murphy et al. 2008; Schwab and Sala-i-Martín 2012). Due to these very unfavorable environments, regional design centers have tried to partner with institutes of technology (mainly in the South), an association that could be very fruitful for providing regional design support, in particular for improving industrial processes and products with higher quality.

Even though this solution can cover some lack of funding and design support by government entities, it should be considered a possibility for supporting design initiatives and programs in the short term, but it cannot represent the only one for both carrying out R&D in design and for promoting design. The Government at all levels must assume its role in the country's development by implementing coordinated public policies that invest in: (a) education and thus knowledge to make technology and innovation evolve; (b) quality of life; (c) environmental responsibility, at individual, institutional and industrial levels.

6.3 Design Management in Brazilian Enterprises

Brazilian historical conditions regarding design initiatives, both promotional or policy-related, have demonstrated that there is still a long way to go in order to successfully address the country's R&D, design and innovation issues. Above all, creating real perspectives that include design in the government agenda as an essential condition to approach the country's development and industry competitiveness must be seriously discussed.

In the contemporary world, competitiveness is less associated with individual enterprises and more related to value chains and co-productive systems, including corporate social responsibility (Ramirez 1999; Porter and Krammer 2006). More generally, it is part of economic creative environments, because the capacity to

innovate and develop new products and services involves a multiplicity of activities that are distributed in diverse companies (Wolff et al. 2011).

Consequently, increasing skills are required for groups to act within collaborative networks of organizations that can operate together, as a mechanism to strengthen knowledge sharing, innovation development and the achievement of sustainability (Pertuzé et al. 2010). In developed economies enterprises perceiving the use of design as a crucial element to obtain competitive advantages had a stronger need to strategically manage their project activities, beyond aesthetic concerns (Raulik-Murphy 2010). For MSEs especially, which have limited facilities and resources, the collaborative networks of enterprises are the most feasible mechanism to improve performance.

Although company skills have been studied for decades by international entities such as the Design Management Institute (DMI) and the International Council of Societies of Industrial Design (ICSID), issues of Design Management in Brazil only started to emerge when the market opened in the 1990s. Associated with the increase in competition, the search for international standards of excellence, as well as to the reduction of product lifecycles,[2] these issues directly influenced developing and managing innovation processes in companies (Wolff et al. 2011).

In contrast with countries that have well-structured excellence centers, such as Finland, Canada, Italy and the US, in which theory and techniques of design management interact with each other, in Brazil the reality is quite different (Raulik-Murphy 2010; Wolff et al. 2011). Mainly based on practice and confronted with an insufficient number of studies, company design management attitudes reveal lack of knowledge, which represents an opportunity for research and improving knowledge itself. Because of this, Minuzzi et al. (2003) highlighted the need to adopt design management in Brazilian enterprises as part of a long-term program of design, considering the increase in competitiveness associated with the expansion of foreign markets. But, so far, little has been done regarding this issue, in particular in MSE contexts.

Some authors argue that, from the theoretical awareness of design management adoption by companies, it is possible to understand that implementing and managing design processes depends strongly on policies, but this depends on the companies understanding the possibilities that design can open to them first (Mozota 2003; Best 2006; Raulik-Murphy 2010; Wolff et al. 2011). As discussed

[2]The reduction of product lifecycles here refers to the rapid obsolescence of products caused by the increase in consumption, reinforced by the market opening in Brazil. This situation is, however, totally in contrast with the environmental issue of controlling production and consumption practices that aim to minimize environmental impacts, therefore trying to adopt a culture of satisfaction (Manzini and Vezzoli 2002; Manzini and Vezzoli 2002a; Morelli 2007). Some existing approaches have focused on processes (e.g. waste minimization, cleaner production and pollution prevention). Charter and Belmane (1999) and Vezzoli (2007) discuss an Integrated Product Policy (IPP) as a policy concept that considers the lifecycle perspective. Nonetheless, it must include all relevant stakeholders' viewpoints and consider the product development process from idea generation to product management and reverse logistics (i.e. 'end of life' management).

by Kretzschmar (2003), companies present four design profiles, which can be combined with four levels of design adoption (*design ladder*) that influence their performance:

- Step 1: Design is not a remarkable part of PD and it is performed by staff members who are not design professionals. Design solutions are based on functionality and aesthetic perceptions shared by the involved people. End-users' opinions have little or no importance at all;
- Step 2: Design is taken as styling, and perceived only as the final aesthetic finish of a product. In some cases, professional designers may perform the task, but generally other professions are involved;
- Step 3: Design is a process, a method adopted very early in PD. Solutions are adapted to the task and focused on the end-user. They require multidisciplinary approaches involving technicians, material technologists, marketing and organizational staff;
- Step 4: Design is taken as innovation, where designers collaborate with owners and management in adopting innovative approaches and where the design process, combined with the company's future vision and direction in the value chain, is a relevant element.

Similarly to countries such as Italy, the United Kingdom and Canada, MSEs in Brazil represent a high percentage of enterprises, about 95 % of the total, which truly impacts on industrial production and competitiveness results all over the country. On the other hand, confronting these enterprises' general profiles and their stages of design adoption, as suggested by Kretzschmar (2003), with the profile of the majority of Brazilian enterprises, it is possible to affirm that the majority of (if not all) micro enterprises of the furniture sector in Brazil are in Step 1. This means that micro companies mostly do not adopt design, either as a project tool or as a management instrument, and their products are developed either by the owner or by the company's staff, who are not design professionals either.

Most small furniture enterprises in Brazil, and possibly a few micro, as well as a good part of medium-sized enterprises, are positioned in Step 2. Due to the more structured organizational profile required, Step 3 is more likely to involve medium to large-sized companies as occurs in Step 4, where design is taken as innovation, and designers collaborate with business in novel products and services as well as in management issues.

These conditions reinforce the urgent creation in Brazil of long-term design programs and a well-structured design policy, both regional and national, by the government in collaboration with universities and/or research institutions. A feasible immediate solution could be to encourage an effort coming from academic and research design institutions, in partnership with industry federations, to structure proposals of R&D and innovation.

In this way, institutions could act as promoters of design as well as supporters of knowledge within companies, relating to their size (i.e. micro, small, medium or large-sized), but with particular attention on MSEs. Such a starting point could help deal with the several social and environmental problems involved in the

production systems of the furniture sector, not only by stimulating companies to adopt better practices but also by forcing them to assume responsibility for their operations.

6.4 The Wooden Furniture Industry

6.4.1 General Aspects

The adoption of Design by enterprises in Brazil, regardless of their profiles, is still a huge challenge for two reasons. Firstly, effective national design policies are still absent, notwithstanding several, but non-continuous, initiatives; secondly, such a policies will require a great effort and time to become effective. Regional policies are mainly found in the States of Rio de Janeiro, São Paulo and the Southern States (Paraná, Santa Catarina and Rio Grande do Sul) (CSPD 2012). This challenge also regards the value of design within companies. In most cases, design is not clearly communicated and, therefore, not well-understood by Brazilian enterprises, in particular MSEs.

Data from Prado and Bezado (2012) pointed out the existence of more than 17,500 furniture enterprises[3] in Brazil. Out of this total, about 85 % are micro enterprises, 12 % are small, and 3 % are medium and large-sized enterprises (SESI 2011). Mainly concentrated in Furniture Clusters (in Portuguese, *Pólo Moveleiro*), the most important are situated in the South (Bento Gonçalves: 20.8 %, Arapongas: 12.2 %, Curitiba: 9.5 %, São Bento do Sul 5.2 %, Lagoa Vermelha: 1.3 % and Linhares: 1 %) and Southeast (Large metropolitan area of São Paulo: 20.6 %; São Paulo interior: 9.8 %; Belo Horizonte: 8.7 %; Ubá: 6.1 %; Rio de Janeiro: 4.8 %) (Prado and Bezado 2012).

The majority of MSEs are family and traditional enterprises, mostly constituted by national capital (ABIMOVEL 2006; Ferreira et al. 2008). The industry moves a broad network of suppliers: panel industries, metal components and handles, varnishes, plastic accessories, machinery, frames and steel tubes, glass, ready-to-use components and others (ABIMOVEL 2006). Although solid wood[4] is used, reconstituted wooden panels are the main material used, and more than 90 % of its production is oriented to the industries of furniture clusters. A smaller volume is marketed by retailers, with other types of panels more suitable to small companies of handcraft producers (e.g. multi-laminated boards, block boards, and others) (Valença et al. 2002; Ferreira et al. 2008; Lemos et al. 2011).

[3]As Statistics' Institutes base their researches on formal registers, this number corresponds to a partial Brazilian reality. In 2002, ABIMOVEL admitted the existence of about 50 thousand enterprises of in the furniture sector in Brazil, between official and unofficial companies (Valença et al. 2002). Nahuz (2005) even mentions the possibility of 50–70 thousand companies.

[4]Some wood comes both from native areas with environmental certification and some illegal areas, and some comes from reforested areas (e.g. pines, eucalyptus).

In relation to the popular furniture market, Brazil is controlled by large distributors and stores such as Casas Bahia, Magazine Luiza, Ponto Frio, Kolumbus, Colombo, Lojas Cem, Ricardo Eletro, M&M, just to mention a few. The retailer segment is quite fragmented. Stores like Tok&Stok and Etna have worked in specific niches to offer furniture with copyright design (Ferreira et al. 2008). Both stores make constant efforts to increase the diversity of goods, with solutions adapted to contemporary needs and better design quality. In this context, it is fair to argue that these niches, and the stores themselves, are somehow gradually forcing design insertion into the Brazilian industrial sector through a demand-driven approach, even though it still affects medium and large-sized enterprise contexts more.

6.4.2 Sustainability Aspects in Brazilian Companies

The majority of Brazilian wooden furniture MSEs are not aware of the environmental impact and health problems caused by waste generation during production and by incorrect disposal. As literature has shown, it is fundamental to adopt practices that include the lifecycle perspective (Charter and Belmane 1999; Vezzoli 2007), thus acting to control the whole manufacturing process, from initial material selection to the assembly of end products, as well as final waste disposal.

According to Nahuz (2005), less than 5 % of the furniture industries have programs to preserve "Nature" and to prevent environmental impact, and none of them have integrated waste management plans.[5] Even though they use mainly wood and reconstituted wood panels, production is characterized by the use of materials of distinct natures (ABDI 2009), such as: (a) solid wood (e.g. pine and eucalyptus from reforested areas); (b) wood particle composites: MDP, MDF, HDF; particle boards and OSB; (c) wood laminate composites; (d) natural lamina of wood, artificial laminas, plastic lamina, resins; (e) metals; (f) chemical products (adhesives and finishing); plastic; (g) glasses, crystals and acrylics; (h) textile fibers and leather (natural and synthetic); and (i) ornamental stones.

The diversity of materials and the volume of waste generated from production processes confirm the great complexity for environmental management in the Brazilian furniture industry. The complex mixture of waste (e.g. different dimensions, characteristics, contamination levels) is a considerable obstacle for waste management (Kozak et al. 2008).

In addition to affecting the health of employees and causing hazardous environmental impacts (e.g. land and water contamination, pollution from burning, etc.),

[5]In short, the Solid Waste National Policy instituted by Federal Law no. 12.305, 2010-08-02 points at the following concepts: (i) Shared responsibility in the products' life cycle; (ii) Reversal logistics; (iii) Sector agreement (Cedi 2010). However, as government or competent entities do not control compliance with the law, companies totally neglect their responsibility.

the final inadequate waste disposal directly affects the neighborhood of the areas of illegal landfill sites. Furthermore, due to organizational problems, the depots of wood refuse inside the companies attract insects, making attacks and infestation of the area more likely (Nahuz 2005; Kozak et al. 2008).

Another serious problem regards the central exhaustion systems to collect dust coming from cutting, rasping or planning, which are found in only 13–15 % of furniture industries (mainly in clusters). In addition, the use of personal protective equipment (PPE) is usually neglected. This low working condition represents quite a serious health problem to employees who work continuously in polluted environments (Nahuz 2005).

Although the evident absence of environmental awareness and some kind of alienation regarding compliance with existing norms within the Brazilian furniture sector, sustainability is a pressing issue. Hence, the environmental and social aspects of enterprises, and particularly in MSEs, are an indispensable condition to improve their competitiveness in the global market. Donaire (1999) sets some gradual transition stages companies usually follow when incorporating environmental control as a competitive advantage:

- Phase 1: control of emissions. Practices are only related to the installation of equipment to control emissions of pollutant elements. The production structure remains the same;
- Phase 2: prevention of pollution. Practices involve the selection of raw materials, development of new processes and products, re-use of energy, waste recycling and integration with the environment;[6]
- Phase 3: integration of environmental control in the company's management. Environmental issues require a meaningful change in the company's strategic planning.

More advanced companies can already operate in more evolved phases of waste control, for example:

- Phase 4: integration of environmental control in the company's operations core. As the main principle is to reduce waste, companies work with their clients to extend the life cycle of products, with take-it-back programs and similar initiatives;
- Phase 5: implementation of an overall and systemic vision in which the operations include life cycle services, thus working as a continuum for controlling waste, inside and outside the company.

By now, the subject of sustainability in enterprises must also include social concerns. Companies need to become committed to it and assume effective practices as routine operations (Porter and Krammer 2006; Nidumolu et al. 2009).

[6]In phase 2, sustainable design helps define the main requisite for creating friendlier and more responsible products and services. These aspects were discussed in this research, since they form the conceptual reference adopted to create and prototype the artifacts.

Nonetheless, as behavioral changes occur over long periods of time, it is possible that, to take on such responsibility, companies should be pressured by laws or new environmental regulations in order to comply with these responsibilities more rapidly.

6.4.3 Challenges for the Brazilian Furniture Industry

For Ferreira et al. (2008), the Brazilian furniture industry has not followed the progress of Brazilian industry in general. While the production value remained almost stagnant, work productivity and aggregation of value to the product went backwards. The only aspects that have provided a few positive results have been those related to work and exportation. But even in these cases, performance is quite inferior compared to the Brazilian industry in general. According to PBD (2006),[7] the furniture sector present fragilities and needs strongly related to Support, Education and Promotion of Design within enterprises, MSEs in particular.

These aspects reinforce the necessity of analyzing the critical factors for the industry's competitiveness. However, such an analysis must consider the heterogeneous character of the production system of the national furniture industry, in which a coexistence of enterprises with highly distinct competitive skills has been observed (Santos et al. 1999; Valença et al. 2002; Ferreira et al. 2008). The critical factors mentioned are commented as follows:

- capacity to innovate and differentiate products, substantially, by the incorporation of design;
- production process improvement through both the absorption of new machinery and equipment and by increasing scale and scope;
- incorporation of new inputs and materials into the production process;
- adoption of organizational innovations to modernize and rationalize the production processes and commercial activities of industries;
- strengthening of the Local Productive Arrangements (APLs).

One remarkable weakness of furniture MSEs in Brazil is the lack of proper knowledge to deal with deeper technical problems, including design. Rarely do they adopt strategies by using design as a competitive advantage. This is not just related to product innovation itself but, mainly, to the absorption of a design culture (Ferreira et al. 2008; ABDI 2009) in MSEs. By addressing design management

[7]A report elaborated in 2006 by the Brazilian Program for Design (PBD) set some demands for the sector. Two aspects are worth mentioning: (1) it is the most recent document written by the PBD that analyzes the furniture industry in Brazil; (2) most of its observations are still valid. However, failure to update such data reinforces the short-term character of design policies and the non-continuity of actions of the Brazilian furniture sector. Therefore, if innovation and competitiveness depend on continuous new inputs and resources to succeed, the absence of data which indicates the weaknesses of the sector shows this is a hard task.

issues (Best 2006; Wolff et al. 2011) and with collaboration through design, such an adoption should enable a collective efficiency (Caniëls and Romijn 2001) and would force the implementation of design policies that can support the evolvement of companies (Raulik-Murphy et al. 2008; Raulik-Murphy, 2010).

Hence, the improvement of MSE conditions depends on well-planned, contextualized and systemic long-term interventions, which focus on the real and specific problems of the industries, suppliers and other collaborators to increase their interest in skilled knowledge and business evolvement. In this context, regional Design centers play a key role. As MSEs cannot sustain individual Design departments, collective centers could optimize efforts and improve results; operating in collaborative networks can strengthen the impacts at local level.

Even though new equipment is acquired, high-tech machinery 'cohabits' with obsolete equipment in the same production line (Ferreira et al. 2008). Organizational innovations are also limited to medium to large-sized enterprises. MSEs usually maintain very strong handcrafted production that limits productivity and reduction of costs. Nonetheless, the absorption of new technologies is related to the interest of the company in moving to high-tech facilities instead of continuous operating in craft processes, therefore offering more "human touch" furniture.

Smaller enterprises must use the correct mechanisms of support from the government, industry federations, associations, research institutions and other bodies, that allow them to continuously incorporate organizational and technological innovations. Policies that embolden the technological advances could favor higher gains in scale by increasing production flexibility, improving product quality and increasing the productivity of the sector (Ferreira et al. 2008; Raulik-Murphy et al. 2008).

A last competitive factor that must be considered is to strengthen the Furniture Clusters in such a way that they increase the advantages of agglomeration. For this, the development of collective actions with a cooperative character is desirable, within collaborative networks, enabling proposals that aim at reducing the high vertical system of the supply chain. Development of the APLs is a key element for the industry's competitiveness, especially for the smaller companies.

With this, MSEs can expand the opportunities from external positive changes (regarding economic benefits and dealing with environmental or social problems as well) generated in the surrounding region, due to the increase of many kinds of demands (e.g. material, machinery, skilled labor, services in general) (Caniëls and Romijn 2001, 2003; Ferreira et al. 2008; Consolati 2009). However, the formulation and adoption of these policies must take into account the different clusters that compose the Brazilian furniture industry, thus proposing contextualized strategic plans.

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Chapter 7
The Context of Intervention in Brazil

Abstract This chapter describes the local context of the intervention—the city of Uberlândia, Minas Gerais State, Southeast of Brazil, with the specific issues related to previous experiences to improve the furniture sector. The intention of such a content is to provide the visualization of the current scenario—individualist, isolated and little innovative among the Micro and Small Enterprises of the furniture sector, in order to understand the challenges faced to achieve a more sustainable path by building an Inter-organizational Collaborative Network.

Keywords Uberlandia/Minas Gerais State/Brazil · Challenges for brazilian furniture MSEs · Brazilian fragmented design system

7.1 The Furniture Sector of Uberlândia/MG

Uberlândia is the main city for nine neighboring smaller cities and represents 70 % of the regional demands for goods and services. However, despite its relevance to the micro-region, the existing local scenario is marked by a fragmented Fragmented Design Systemdesign system among different institutions, academic, government or business-related.

The wooden furniture sector here is a reproduction on a smaller scale of the general situation in Brazil. Out of the approximately 800 MSEs (Oliveira et al. 2012), most local businesses are oriented to bespoke consumer orders. These orders are manufactured in a craft production process, which means a highly customized single unit production (Chinnaiah and Kamarthi 2000). Nearly 85 % of MSEs are not officially registered, and most of them work in unsafe facilities with poorly adapted and obsolete machines, employing unspecialized and cheap laborers. Most MSEs (official and unofficial) lack control over material consumption and waste disposal.

The awareness of best practices that could reduce environmental impacts supply innovation and bridge technological gaps, when noticed, is not enough to

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change the scenario. Moreover, out of the 15 % officially registered MSEs (about 120), only 50 % are members of the Furniture Union (SINDMOB). With the exception of the few MSEs which work with interior designers and architects in personalized projects, the sector is strongly characterized by an inertia regarding the pursuit of organizational, technological or knowledge advances, which reflects its lack of leadership (SENAI et al. 2006).

The local existing MSEs present different development levels and only a few of them have a feasible potential for adopting more sustainable practices (even though still based on craft systems) Systems due to limited skills in regarding aspects of design, managerial issues and operations. As stressed by several authors (Magalhães 1994; Bruce et al. 1999; Manzini and Vezzoli 2002; Mozota 2003; Best 2006; Morelli 2007), Design can be a major support to production and innovation, whether technological or sustainable innovations. Thus it could trigger a change in the status of the furniture sector in the region.

The status of their performance is described below.

- Loss of time and high costs: unique and highly personalized artifacts take much more time and energy to manufacture. This jeopardizes efficiency and competitiveness among MSEs. Materials acquired exclusively for a single project often generate waste, as most times these material specifications regard only one object/service;
- Inappropriate material selection and lack of optimization: single pieces jeopardize the optimization of material use during/after production to the specific needs of individual projects. The limited local variety of materials for the furniture industry demands purchase from other regions. However, due to small buying volumes, the prices become too high and unfeasible;
- Products with difficult assembly/disassembly systems: this aspect hampers conservation and transportation, as well as the final delivery of goods. Some problems are related to assembly due to the building's imperfections (e.g. alignment of walls and floors) as well as the use of nails, glue and other fixing components to assemble or repair parts;
- Lack of a flow of orders: the make-to-order production relies on a continuous flow of orders from clients. Even though nowadays the local market is fuelled by the rise of residential building construction, it is also true that access to stores that offer a greater variety of products, accessories and complements such as Tok&Stok and Etna, or even Leroy Merlin, has become much easier. In a near future, this situation may affect negatively local furniture production.

7.2 Challenges for a Sustainable ICoN Scenario

With respect to management issues, almost all MSE managers in Uberlândia and the region are people who have been progressively learning how to produce wooden furniture over the years. Their tacit knowledge has been passed along generations and even in those cases where some practices have evolved, the

machinery and manufacturing are still associated with highly crafted thinking, with a few exceptions.

As pointed out by Atkinson and Meager (1994) and Bruce et al. (1999), MSEs are mainly owner-managed. This reinforces the relation of dependence between MSE and owner, since the owner has the skills. But if the owner is not aware of the potential value of design for his company, or if there is no time to gain skills or to work with a designer in a proper way, the adoption of Design skills by MSEs may be very hard or might even not occur (Atkinson and Meager 1994; Bruce et al. 1999).

According to SEBRAE/MG (2011), there are regular initiatives in Brazil to improve the management of MSEs. However, much remains to be done to professionalize their management attitudes and much more investment is required to improve their productivity and quality. Sometimes, this is due to the general propositions that consultants offer to these MSEs, to lack of mentorship or scarcity of resources. In some cases, the lack of interest by MSEs is related to their poor understanding or recognition of the importance of management in their businesses.

In this case, regionalized policies could motivate enterprises to search for higher efficiency levels as well as to create advantages for their furniture businesses. Policies would support the overcoming of limited technological know-how and even the managerial specialization that MSEs MSEs (Micro and Small Enterprises)have achieved until now. Design policies also stimulate the interest of furniture MSEs MSEs (Micro and Small Enterprises)in seeking design skills in order to differentiate and increase the companies' positioning in the market. As MSEs commonly have economic difficulties to hire designers as a permanent teamwork resource, partnershipsPartnership/Partnerships with the university to have design support until they are able to definitively employ professional designers can be a feasible solution.

However, at times the absence of designers in furniture enterprise environments can represent a problem for improving production and processes. This is usually related to the lack of interest interior designers have with the manufacturing process of artifacts conceived by them or even the interest in participating in MSE operations, beyond the level of the project. Indeed, locally there is pressing need to change the approach to design issues from an isolated aesthetic tool into a strategic key tool for conceiving and manufacturing furniture and, above all, for developing these MSEs MSEs (Micro and Small Enterprises)in the broad sense.

The adoption of the full extent of Design capabilities, however, is still a big challenge. Because of this, the Design Pilot Project (DPP) proposed in this research aimed at enabling novel possibilities to face design issues (in terms of project, production and strategies for MSE operations) as well as to contribute to their adoption in a collaborative way.

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Chapter 8
Design Pilot Project Strategy

Abstract This explains the MODU.Lares Project Intervention by describing the development process and the idea of the *System-ability* as a promoter of sustainable and innovative changes. The chapter presents also a discussion of the elements used as Boundary Objectsduring the research—prototypes, meetings, exhibitions as well as pilot project, in its whole. This action-based project is an important contribution to the local context because it updates the MSEs' conditions through questionnaires and field research (the most recent official data of the sector regarded 2006). Hence, even though this research represents a small sample in the universe of an estimated 800 MSEs (among formal and informal ones), the experience serves as a base for future works and provides insights on how to create strategies for the sector, involving more MSEs.

Keywords System-ability as strategy · Network-based experience in Brazil · MODU.Lares Design Pilot Project · Strategy for Design Promotion in Brazil

8.1 The MODU.Lares Project Definition

The MODU.Lares Project focuses on the *System-Ability* of a given context to act as a promoter of sustainable changes. As previously defined (see Chap. 2), such a *system-ability* approaches the idea of enabling abilities through a collaborative network system among actors with different skills and roles, who act together to make such a system function. This term is also be coordinated to the 'sustain-ability' term to refer to the capacity of sustaining an intervention that is both environmentally and socially responsible by building a collaborative network.

A strategic DPP was assumed as a stimulus for collaboration among stakeholders and, thus, as a trigger to change from a fragmented local system to a more interdependent and sustainable dynamic scenario. For this reason the MODU. Lares Project was developed by building a network-based experience with different actors. The scenario building as a consolidated tool for strategic design and a

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way to visualize an enabler project (Meroni 2008; Zurlo 2012) was the guide to support decision-making processes.

The MODU.Lares Project started in February 2011, lasted 18 months and was divided into two main phases:

- The initial phase (6 months), carried out by the researchers and SINDMOB (Furniture Local Association), aimed at establishing the different partnerships and at checking the MSEs' availability for taking part in the experience. It included several visits to sectors of the Municipal Prefecture and of the Federal University to present the proposals, and to learn about their interest and willingness in supporting the initiative. After the first meeting with SINDMOB in August 2010, having obtained its agreement, and in accordance with the planned actions, the proposal was presented to the members of the SINDMOB.
- The second phase (12 months) regarded the DPP implementation, based on the actions defined as necessary to carry out the experience. It included the design of the artifacts to be prototyped by MSE partners, which would work as instruments for common understanding, in order to explore new furniture production solutions by practicing—producing, analyzing, evaluating results and future perspectives, collectively.

8.1.1 Prototyping Phase

In the prototyping phase (02–26 January 2012) the artifacts were produced in a two-phase step: first as a mock-up and then as a prototype. Before starting the production phase, there was a meeting with the MSEs, the Furniture Producers Union and the University to discuss the design solutions. The prototyping phase was planned based on the artifacts' features and MSE structural conditions, i.e. the means and the equipment available to MSEs.

The entire process was supervised by the researchers and two collaborators. The mock-up production aimed at evaluating the technical and aesthetic solutions of the objects, enabling the producers and researchers to re-design them for the next step. After the mock-up and the prototyping rounds, there were meetings with all the parties involved to evaluate the results of production, which led to some decisions and to preliminary conclusions.

8.2 MODU.Lares Project as a Boundary Object

In innovation processes that include the development of new artifacts or the adoption of new practices, boundary objects have two important capacities. One is a practical capacity, arising from: (1) the need for a common language that can be shared by a group when performing specific activities; (2) the feasibility of working as a means to represent differences and dependencies at a given boundary. The

other capacity is political, because it brings about conditions to transform existing knowledge mutually, thus contributing to creating a new one that can solve the negative results identified by these new experiences. These capacities lead participants towards a more shared knowledge and, in consequence, reduce misunderstandings and differences (Carlile 2002, 2004).

In addition to this, the collective learning that comes from knowledge shared among participants involved in innovation processes, development of new artifacts or practices includes other aspects, such as: a) the contextualization of problems, the flexibility for dealing with problems; b) the deeper understanding of technologies and methods, which requires engagement of participants in practice; and c) the recognition of the importance of investing in practice to develop new paths to deal with organizational problems, as a whole (Carlile 2002, 2004; Spee and Jarzabkowski 2009).

Within this research, the notion of boundary objects was associated with four different dimensions: Prototypes, Meetings, Exhibitions and the MODU.Lares Pilot Project as a whole process. These intended to serve as an element of common language to facilitate communication and to encourage commitment and synergy among the different groups involved in the inter-organization collaborative network.

The Meetings (Fig. 8.1) and the Prototyping Phase (Fig. 8.2) were key steps to stimulate collective learning among the MSEs involved in the MODU.Lares

Fig. 8.1 Meetings in different times of the DPP development

Fig. 8.2 Discussions around the prototypes

Project. By using tangible objects to share knowledge, those steps contributed to mutually exploring new visions and understanding through practicing and producing.

It is relevant to report that during the prototyping period the entrepreneurs behaved in different ways when together. Some of them were quite engaged with the DPP development and participated effectively in the exchange and in increasing knowledge among the group. Others were less involved, possibly because overburdened by daily tasks or because they did not comprehend the significance of new skills, or even because they were not interested, despite their inclusion in the project.

By approaching the Exhibitions (Figs. 8.3 and 8.4) as strategic boundary objects, the aim was to enable a common language to interact with the broader public by using tangible objects. Such exhibitions represented an opportunity to increase society's awareness of sustainability, as well as to demonstrate to MSEs that increasing competitiveness through the established collaborative network was feasible, and to stimulate its continuation.

As a strategy for Design Promotion, the exhibitions also aimed at communicating to other MSEs, the government and society, the competitive advantages that design can provide to the region's economic and social development.

In order to fully explore the possibility of interacting with the broader public, three exhibitions were held within the scope of this research. The first, named

Fig. 8.3 First prototypes Exhibition (January 2012)

Fig. 8.4 MODU.lares prototypes exhibition (June 2012)

'Prototypes Exhibition', was held in January 2012, whereas the second, an 'Intermediate Exhibition', was held at the beginning of June 2012. The third, named 'MODU.Lares Furniture Exhibition', held at the end of June 2012, included some 'rooms' in which it was possible to combine the solutions offered by the modular nature of the artifacts.

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Chapter 9
Research Findings

Abstract This chapter analyses the partnerships proposed by the MODU.Lares Project, their effective participation or absence in the collaborative network, which was based on the evaluation of the results of executed actions by using the MP (Modu.Lares Project) tool and also by monitoring all the process. In relation to the adopted Boundary Objects, the analysis reveals important issues when dealing with tangible and intangible elements and highlighted differences between the entrepreneurs in terms of engagement and commitment. The chapter also presents some emergent changes in the local scenario and the contribution to stimulate the design policies creation in contexts similar to Brazil.

Keywords MODU.Lares Project as Boundary Object · Collaborative Design Projects in Brazil · MP Design Policy Cycle in Brazil

9.1 MODU.Lares Project Analysis

The MODU.Lares partnership proposals were oriented by the ICoN model (see Chap. 5). However, the engagement of individuals and organizations in partnerships which have collaboration as the main objective depends on several conditions and intents. The more effective the involvement, the more promising the results associated with an experience, since the actors work collaboratively with each other. Some conditions can, nonetheless, also affect negatively the whole collaborative network building process.

In such cases, continuous efforts and, most times, new strategies are needed, as occurred in the MODU.Lares Project, in order to achieve the most favorable results. In this respect, it is worth noting that the phases of contacting potential partners and of establishing the effective partnerships were the most demanding steps of the Project, not only among the several organizations desired as partners, but also among the MSEs themselves.

There are, in fact, many conditions that jeopardize engagement and collaboration among organizations. Even though some of them are very often pointed out

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as part of the relations among organizations of the same type, they can be equally valid for different types as well. Among the aspects that prevent collaboration, some are related to:

- lack of interest in making a well-coordinated effort to solve a problem together (Roschelle and Teasley 1995; Brna, 1998);
- difficulty in communicating (Burton et al. 1997; Brna and Burton 1997; Brna 1998);
- little social or professional relations among parties, which is a basis for trust, transparency and belief in mutual efforts to achieve group goals (McCormack 2001; Kloth and Applegate 2004; Hocevar et al. 2011);
- commitment to the individual (and implicit) responsibilities each participant must take on in relation to the whole task (Brna 1998);
- difficulty of assuming both a continuum of practices and changing internal policies to create alignment and co-responsibility with others over whom there is no direct influence (Kloth and Applegate 2004)—even indirect influence is quite relevant;
- limitation in defining common goals, values and procedures (Pareek 1981; Kloth and Applegate 2004);
- poor capacity to visualize the interconnected system with interdependent actions (Elkington 1994; Sachs 2002; Redclift 2003; Manzini 2006) which generate positive or negative cause/effect reactions;

All these arguments were identified during the MODU.Lares Project development. Notwithstanding the efforts dedicated to establishing the collaborative network, the evident lack of engagement of relevant partners—i.e. local government, other associations and NGO—limited, to a certain extent, the achievement of a higher level of sustainability and innovation in the local context. Based on the ICoN model, Fig. 9.1 demonstrates an overall vision of the interactions among organizations activated by the project development.

9.1.1 Effectiveness as a Collaborative Project

By approaching the concept of boundary objects as an element to communicate among organizations, the MODU.Lares Project provided a space, a basis for their interaction around a common focus (Jarzabkowski and Wilson 2006) through the use of a common language (Carlile 2002, 2004). In such a space, current and new knowledge were mutually explored, and even if in different intensities among partners, this contributed to producing more shared knowledge (Carlile 2002), thus trying to crossing the organizations' boundaries. Such a basis included all the elements involved in the research: *meetings*, *prototypes, exhibitions*, *the pilot project* itself. Each one was recognized with a different intensity by the partner individuals and organizations, which reflected in its effectiveness, as described below:

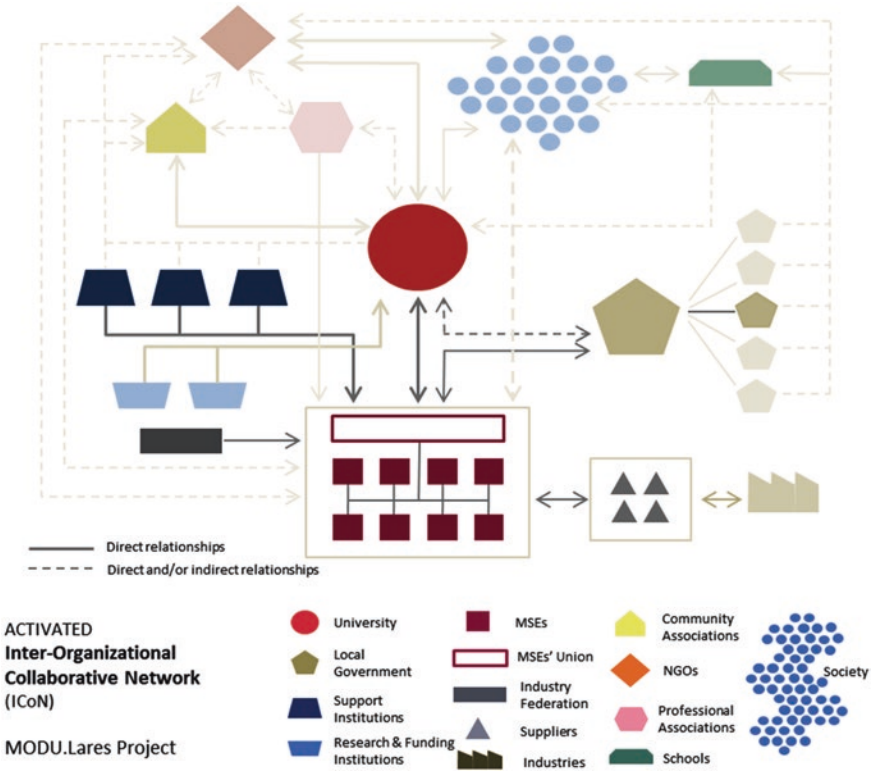


Fig. 9.1 The ICoN activated by the MODU.Lares Project (Nunes 2013)

9.1.1.1 Meetings:

The common language established in the Meetings encouraged communication among participants based on the focal points, i.e. the actions and activities proposed during the project. At the same time, not only did it provide a means to make communication easier, it also highlighted differences. At times, divergent points of view or unfriendly ways of expressing ideas among participants when facing the same issues prevented participants from crossing boundaries. This, therefore, affected the actual opportunity for some of them to continue the collaborative path they had started.

Even though some partners were committed to the goal of collaborating and of improving themselves, therefore seeking the best path to achieve it, trust and mutual respect are still a hard challenge.

9.1.1.2 Prototypes

Differences of perception among MSE participants were noticed. Despite this, the Prototypes were recognized as the most efficient boundary object of this research. Because their characteristic is being tangible objects, they worked as an interface, establishing a common language between entrepreneurs and researchers, and among entrepreneurs themselves. From this, they effectively contributed to stimulating discussion and to sharing knowledge, thus supporting the collective improvement of solutions through a learning process.

Starting from their tacit but also pragmatic knowledge, entrepreneurs were able to explore ideas, built from all the participants' intervention in a very active attitude that aimed at a collective benefit. As occurs with other elements (i.e. meetings and exhibitions), the collaboration assumed different levels of engagement, which also helped identify the potential of participation and leadership of some partner entrepreneurs.

9.1.1.3 Exhibitions

The Exhibitions were a means to communicate with the broader public also by using tangible objects as the common language. They functioned as an efficient channel of interaction, stimulating knowledge and information exchange among visitors, students and researchers. The three exhibitions allowed to approach sustainability issues, technical solutions and innovation in conversations with the public, in general, also because there was great media support for all of them.

Furthermore, it was a meaningful time to identify the interest of the target public*, in loco*, in the solutions proposed with such artifacts. Indeed, by using the tangible objects, visitors had the opportunity to learn more about the concepts adopted for the objects, such as customization and flexibility. The interaction of the public with the prototypes also allowed them to express their opinion about those solutions.

On the other hand, the engagement of entrepreneurs in the exhibitions was less intense than expected. Actually, it remained more of an observation instead of active participation in conversations with the public and even with the support institutions and local government. This issue illustrates the argument of Van de Ven (1986) about the difficulty experienced by participants involved in a new project or job in paying attention to opportunities or even managing ideas into actual practices.

9.1.1.4 Pilot Project Process

The use of the MODU.Lares Project as a broad strategy tool to interact with the political context is still an unfinished element. The project can be recognized as an important element of connection. It was an instrument to foster inter-organizational

collaboration among enterprises and support institutions guided by the university, because it was the first time in the region that a group of organizations (businesses or otherwise) was involved in a common proposal with a common objective.

From another perspective, MODU.Lares also revealed feelings of distrust among MSEs, in particular regarding the effective contribution that support institutions can provide. As noticed, the engagement of such support institutions only occurred through specific short actions, without any interest expressed in building a long-term collaborative project with either the furniture sector or with the university. In relation to the local government, its engagement is a still a huge challenge to overcome. Communication with the several sectorial departments of the City Hall and with Associations and NGOs, considered crucial to potentiate the outcomes of a collaborative network, was not established on a sufficient level of agreement to allow their effective participation.

With respect to this, some considerations are important. In order to reach more comprehensive positive impacts, partners of an ICoN must understand the crucial interdependence of operations that make the system function—including individual responsibilities and time for responses. Equally relevant is the integration of the best possible variation in partner types, which can provide specific and effective skills and responsibilities to support its functioning synergically.

In the case of Uberlândia, a historically fragmented system, with poor record of sustainability concerns and innovation aspects, the integration of actors was a little limited. Even though the number of partners of the same type was significant (eight MSEs) considering these local conditions, only a few of the other types of actors (businesses, university, support institutions and local government) were engaged. With this, it is possible to claim that the MODU.Lares Project worked as a boundary object far more among MSEs and university. In relation to support institutions, the process was much less expressive and, in the case of the local government, interchange and collaboration were practically negligible.

The Design Pilot Project worked as a stimulus for MSEs to start a long process towards more evolved scenarios. It is also true that the information built with, and the outcomes from, the MODU.Lares Project execution provided a basis for further proposals with the furniture sector, likewise aiming at enlarging the range of partner organizations. In future opportunities, this intends to foster the creation of Design policies in the region. However, it will be possible only through the effective engagement of new and relevant partners, committed to the intention of the complex inter-organizational collaborative network.

9.1.2 Contribution to Sustainability and Co-production Value

The MODU.Lares experience demonstrates the feasibility of exploring new opportunities through collaboration among wooden furniture MSEs that, therefore,

contribute to improving such solutions. However, this effectiveness depends on the willingness of partners to try new paths and to assume the control of their improvement in sustainable and co-productive processes. The absence of training in technical and organizational skills (initially planned to be provided by support institutions) was a relevant shortcoming. As it did not occur, MSEs were poorly assisted in these issues, which would have increased the chance of their evolvement, as well as potentiating collaboration among the group.

Moreover, actual improvements demand more time to be measured than that usually covered by a pilot project (in the MODU.Lares case, an 18 month experience). Nonetheless, through the assessment tool used, the results reveal that the deeper the engagement of partners, the more evident the capacity for absorbing new knowledge, which, therefore, broadens the perspectives for a further and concrete improvement of MSEs.

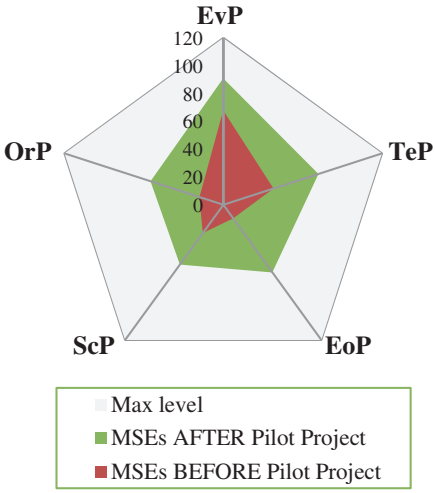
As a collective experience, the outcomes of this Project can be used as a lesson for scaling up, by including more types of actors, as planned from the beginning of the ICoN model. It increases the chance of raising the successful results because it responds to more issues through the interdependence of actions among a wide group. At the same time, it also increases the complexity of the addressed problem (Van den Bosch and Rotmans 2008; Vreugdenhil 2010). Due to this, it is crucial to address individual improvements in MSEs, even if it occurs in parallel with the collaborative network.

9.1.3 Emerging Changes in the Local Context

An overall analysis of the project shows that difficulties of interaction are stronger than production limitations or the adoption of new production concepts, even though these issues demand more and continuous attention to sustainability concerns. Due to this, and in order to minimize conflicts generated by misunderstandings or by difficult discussions, a feasible path to potentiate the results of collaborative activities is to invest in individual organizational skills, including interpersonal abilities.

Figure 9.2 shows a radar map with the general average of results, gathering the partial results of each company to create only one average. This helps to visualize the evolvement of the enterprises' performances by comparing the two analyzed moments.

Despite the constraints in establishing the partnerships and engaging the partners concretely, the results obtained from the analysis of the experience, if compared to the existing reality, indicate a positive evolution. Notwithstanding some limitations of the assessment tool, which should be widened to assure precision of assessment, its adoption provided a broad image of the scenario, in order to orient future actions. These directions are strictly connected to the scaling up of the experience.



Indicators	MSEs Before Project	MSEs After Project	Max level
EvP	68	91	120
TeP	38	72	120
EoP	12	60	120
ScP	25	53	120
OrP	18	55	120

Fig. 9.2 Radar Map: Summary of Comprehensive Results of MSEs (June 2011; June 2012)

9.2 Contribution to Foster Design Policies in Fragmented Contexts Similar to Brazil

The contribution of the MODU.Lares Project to scientific knowledge is mainly associated with two aspects: a) the use of Boundary Objects to establish a common language among different parties; and b) the adoption of a Collaborative Design Pilot Project as a strategic trigger to foster design policies.

As identified by Raulik-Murphy (2010), especially in developing countries, the creation and implementation of design policies is limited to the beginning of the process. According to the author, when the policy document is opened to preliminary discussion by members of industry, universities and government, to be further ratified as a policy by the last one, it is often interrupted due to the absence of government support.

Even though Pilot Projects were presented as a useful instrument to find out whether policies do or do not work as intended, in contexts where no policy or no experience in collaborative networks exists, there is no indication of how to proceed to connect pilot projects to policies, in particular those involving design. Hence, by combining the features of the MODU.Lares Project and Raulik-Murphy's model, such a successful pilot can work as a strategy to trigger a collaborative culture in contexts where there is no established collaborative environment.

With it, it is possible to better identify a problem or an opportunity of the context (because it was already tried within a collaborative group) in order to encourage the creation of a design policy, thus minimizing failures or interruptions in its implementation process, generally due to the non-recognition of the proposal by the government (and, thus, its non-ratification).

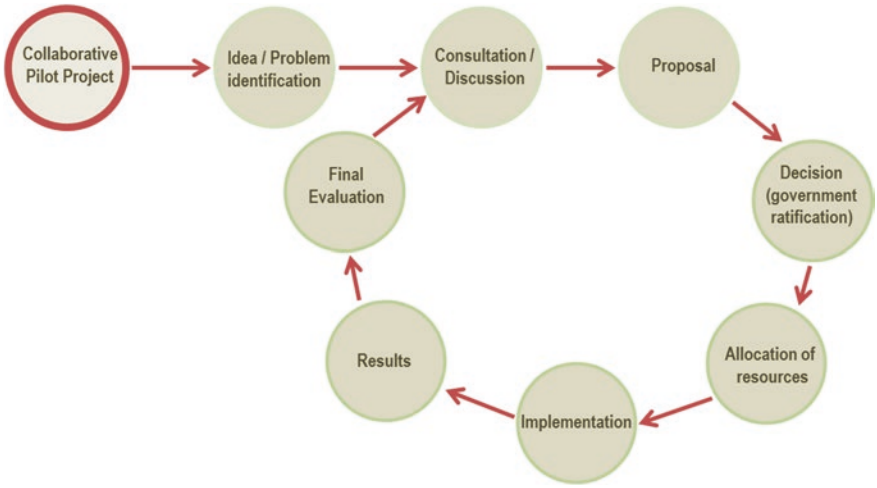


Fig. 9.3 MP Design Policy Cycle proposed by Nunes (2013), built on Raulik-Murphy (2010)

In this case, the MODU.Lares Project amplifies the generic model discussed by including a Collaborative Design Pilot Project as a first step in a policy cycle. The term MP Design Policy cycle (from ***M***ODU.Lares ***P***roject) refers to this process (Fig. 9.3). This previous step intends to encourage the advancement to the subsequent steps of the cycle, which mainly depends on the government's ratification as a decision for continuity.

It is worth noting that, even though the execution of a Collaborative Pilot Project at the beginning of a policy process can trigger collaboration through its dynamic nature, policies tend to be continually adapted, depending on the context and on available resources. In any case, the inclusion of a preliminary step—the Collaborative Pilot Project—in such a model contributes towards the development of a collaborative culture as well as stimulating participation and, thus, to the definition of a common goal.

Despite the differences between how policies are made and how they should be made (i.e. between *practice* and *theory*) (Hogwood and Gunn 1984), awareness of the policy process during its development is essential to minimize risks, improve opportunities of successful implementation and increase results. This means that evaluation must occur during the role process to adjust procedures, when necessary. The final evaluation regards a comprehensive analysis of the experience that can contribute to its scaling up, thus including other organizations as stakeholders or even extending the policy to other categories of business organizations.

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Chapter 10
Final Recommendations

Abstract This chapter encompasses a summary of partnership results, the discussions and perspectives for a new scenario, by discussing the roles and responsibilities for collaborators in inter-organizational collaborative networks. Issues such as leadership, the consolidation of the sector's governance and the importance of the actions planned to occur in the three levels of managing a company (operational, tactical and strategic) are also discussed. Finally, the chapter provides some guidelines to all the typologies of actors that had participated in the MODU.Lares Project as well as to those who are expected to participate, that can be connected to other similar contexts, with few adaptations, in order to achieve more positive results.

Keywords Network of companies in Brazil · Value of co-production practices in furniture MSEs · Learning and innovation in Brazilian MSEs

10.1 Recommendations for Future Collaboration

The conceptual ICoN Model within this research considered that interconnections are quite relevant to improve skills, to increase competitiveness as well as to motivate progress towards more sustainable scenarios. To achieve the most concrete and positive impacts, each participant must understand that operations are interdependent for the system to function as a whole. The ICoN Model upholds that the relationships are more or less intense, depending on the profile of each member, and vary in terms of intensity or continuity according to the role of a specific partner.

Thus, in order to facilitate future collaborative work and to obtain more commitment from other organizations, some reflections and guidelines to increase the impact of the experience are proposed. By analyzing the MODU.Lares Project experience, the outcomes are interpreted and translated into instructions to new partners which could be interested in taking part in a collaborative pilot project, with similar profiles. Moreover, future experiences must strategically include new stakeholders to collaborate in a coordinated effort, in order to achieve more successful results.

F. Zurlo and V.d.G.A. Nunes, *Designing Pilot Projects as Boundary Objects*, PoliMI SpringerBriefs, DOI 10.1007/978-3-319-23141-9_10

10.1.1 Micro and Small Enterprises

This work highlighted the significance of increasing skills and sustainability awareness in relation to many aspects for more responsible practices within the context of MSEs. Indeed, this increase, which aims at raising their sustainable performance as a competitive strategy, depends on a change in the way MSEs deal with problems, and requires new knowledge and a change in behavior. In particular, aspects such as design and management issues can help MSEs to improve their operations towards sustainability, not only with regard to environmental impacts (both inside and outside companies) but mainly in relation to economic and social issues. Due to the problems faced in daily practice (such as work overload), most of the time MSEs do not engage in processes to search for more knowledge that could contribute to their evolvement, even though this improvement is the basis for it. Precisely for this reason, a collaborative network can assist MSEs in achieving better operational levels and encouraging the value of co-production practices.

The MSE partners in the MODU.Lares Project only partially assumed their individual roles for enhancing their skills. Thus, to minimize failure, the attention dedicated to organizational and to technological and innovation issues must be translated into raising management levels in MSEs. Above all, the increase of such skills must be combined with the increase of interest in dealing with the environmental problems connected to each MSE operation. These aspects, if coordinated with a main collective intent, can support their better interaction in collaborative networks, which is an important factor in their evolvement.

The leadership of the sector is a crucial aspect. Any desired change that may affect, individually, the *status quo* of the business organizations is often associated with their capacity to define collective goals. Hence, it is necessary to reinforce the MSEs' integration in the Local Associations or Industry Unions. This aims to more easily access funding and other incentives to invest in research and/or technology, including their facilities.

The consolidation of the sector's governance can also encourage the scaling up of the experience with other groups. This depends, however, on the previous preparation of new partners to integrate a collaborative project and on the quality of learning and innovation that individuals are able to share among the different stakeholders and contexts. Nonetheless, by increasing their awareness of such issues not as distant problems identified outside the company but *mainly as internal concerns*, this will also reflect in successful external benefits generated by the individuals' improvements.

Some recommendations for the MSEs are, thus, associated with these issues, and regard different levels of practices: the operational level, the tactical and the strategic level of performances.

10.1.1.1 Advice at the Operational Level for Current Practices

- Assume a more pro-active attitude regarding the current problems and opportunities, searching for novelties and solutions that can support its evolvement and better operations. This can occur by participation in technical and professional events, trade shows or exhibitions addressed to entrepreneurs, MSEs of a specific sector or businesses as well;
- Identify internal barriers:
  - for the adoption of a more efficient and sustainable production, such as problems with industry layout, machinery breakdowns, material scarcity and correct selection;
  - regarding the business and design management and all possible solutions to overcome them, at individual level. Solutions can, however, rise from networks of MSEs, and be held by the university or support institutions;
- Implement operational control at least to attend to the aspects of cleaner production. This will contribute to reducing problems with waste, safety and health of employees, as well as minimizing unnecessary costs with badly used material;
- Adopt new production practices by analyzing projects, to optimize the consumption of materials and reduce waste. Such practices must include concepts of design to lead the MSE (in the medium-to-long term), towards its repositioning in lean manufacturing systems;
- Recognize mutual dependencies and interactions, to gradually and willingly become involved with individual responsibilities to achieve the collective goal;
- Build mutual respect and trust by attending meetings to share knowledge, information and experiences that will contribute, gradually, to developing a collaborative culture in the sector;

10.1.1.2 Advice at the Tactical Level Related to the Planned Actions

- Create a group of MSEs which assumes the leadership of the sector, to work on the continuity of actions and collaborative activities. This group can initially gather partners which have participated in previous experiences, with the interest and ability to communicate about different points of view. Although differences of opinion emerge, it is crucial to define a common goal to minimize risks of failure or of ceasing;
- Plan training courses and strictly focused consultancies to overcome the production and management weaknesses identified in the process; take part in such activities and implement changes that will actually contribute to improving company operations;
- Commit to a continuous collective learning and decision-making process in a gradual and iterative manner. The individual tasks must support the flow of knowledge, information and interdependence of actions within the ICoNs. This comprises joint action plans and awareness of organizational changes and innovation;

- Establish partnerships with University which can assist with knowledge in design and management concerns, thus contributing to a continuous improvement of the MSEs' skills;
- Maintain updated data on the whole sector involved, in order to help the definition of precise actions to be carried out within the sector and that will conduce to its consolidation as an industry segment.

10.1.1.3 At the Strategic Level, the Advices Regard to the Whole Sector

- Integrate Design—and designers—into the daily practices of MSEs, thus recognizing it as a competitive advantage. It means having design as a strategic tool present in the company's operations, from the conception of new products up to communication and distribution of products;
- Consolidate MSEs' business management skills to support the maintenance of a structured collaborative culture within the sector;
- Engage in decision processes and opportunities for the industry sector regarding local policies, incentives and announcements for R&D, thus consolidating a continuous cycle of improvements for the sector;
- Adopt new manufacturing systems that open new opportunities and markets, but mainly that minimize environmental impacts generated by the industry (in this case, the furniture industry);

10.2 Academic, Research and Support Institutions

10.2.1 University

Within the MODU.Lares Project, the University assumed a vital role in the contextualized initiatives. These initiatives had connected different problematic aspects of a fragmented scenario with occasions for exploring solutions in a very focused way. However, there is no denying that complex projects demand more comprehensive research groups, including members from different knowledge fields, or multidisciplinary teams, in order to design research proposals that respond to the context's needs in the best possible manner.

Particularly in the case of the Design School of the Federal University of Uberlândia/MG, many issues discussed along this research still must be absorbed by the curricular program. This will work towards the construction of a conscious professional designer who will also operate as an agent of change in the city's sustainability levels. When assuming their roles to develop either sustainable products or services, designers become key actors in transforming current working practices into more sustainable ones.

Moreover, such collaborative practices strengthen the social role of the university in working with less assisted contexts, such as the low-income population connected with community associations or non-governmental organizations. The inclusion of these groups in the universe of student experiences, through applied researches or long-term experiences such as pilot projects, can inspire their interest in solving such problems. By exploring creative but efficient manners to face social concerns, students can develop solutions, whether in the design of products, services or even in the design of product-service systems, thus contributing to amplifying their range of action as well as the university's at the same time.

Based on this, the recommendations for the University are translated here and are mainly associated with the fields of Design.

- Emphasize the sustainability and innovation concerns in project disciplines, thus motivating students to face real-life contexts and explore creative but concrete solutions to deal with the issues;
- Establish multidisciplinary research teams with a common focus that investigate the local context—both problems and opportunities—regarding the given sector;
- Strongly encourage research projects involving professors and students from different fields (e.g. design, architecture, management, social and political sciences, geography, engineering, etc.) to lead the students' attention to the whole-system urban context, and to the interdependence of actions and their effects;
- Interact with professional associations to motivate knowledge updating and the adoption of sustainability concepts in projects, in order to increase the positive impacts of services offered to society;
- Approach community associations to identify fields of present and future research studies in design to respond to social needs;
- Collaborate with support institutions and category associations to foster synergy and commitment in collaborative actions and to increase positive impacts in future interventions regarding the given sector.

10.2.2 Support Institutions

Some historical aspects configure the pattern of support institutions like SEBRAE and SENAI in Brazil. In particular, in the furniture sector of Uberlândia/MG, the actions have demonstrated that most of their approaches must be renewed to support local MSE evolution, including the urgent updating of sectorial data. This certainly will work towards broadening positive impacts on the whole economy. Despite several limitations with sectorial leadership that prevent the flow of actions, it is crucial to join efforts to provide the given sector with knowledge, as well as to offer services which meet MSE expectations, and taking into consideration the interconnected system and the interdependence of the proposed actions.

Moreover, support institutions must work to facilitate the integration of small groups of MSEs in order to minimize withdrawal during the training processes. In the case of SEBRAE, there is a minimum number of companies in training courses or other initiatives, which normally restricts participation to very small groups of interested subjects. In any case, a fundamental issue is to pay attention to the real needs of groups related to the institutions (whether individuals or companies) and to search for collaborative partnerships that operate to solve problems together.

From these considerations, some advice to support institutions (in Brazil, represented by SEBRAE, SENAI, FIEMG, IEL, etc.) which operate at the local level but also nationally, is set out below.

- Maintain updated data regarding the whole given sector, to provide more reliable information as basis for more effective interventions;
- Set up support focused on the weaknesses in MSE skills, such as management and financial issues, waste management, market gaps, collaborative culture, among the other services available to them. However, the requirements and specific necessities of each MSE should be given serious consideration, instead of preparing general plans that are not suitable for their actual conditions;
- Broaden the project's vision towards an integrated and interdependent support to MSEs, thus assisting their continuous evolvement until they actually achieve the required skills;
- Amplify the range of services to include the local community, thus making the participation of community associations or members of NGOs viable and providing them with more chances to be re-integrated into society;
- Minimize risks of failure and withdrawal from projects by permitting smaller workgroups, thus inspiring higher cohesion and engagement of participants to effectively contribute towards their improvement;
- Collaborate with the university, in particular in the design field, thus creating a continuous partnership in aspects associated with products, services and processes directly focused on company needs.

10.2.3 Associations and NGOs

In the context of this research, associations are groups of individuals that act collectively towards a specific end (e.g. community groups) or that are united by a knowledge field or profession (i.e. professional associations), which generally do not have the status of an organization, such as NGOs. Despite the fact that the MODU.Lares Project was not able to engage any of these two important categories of partners, such a partnership is strategic to the proposed inter-organizational collaborative network, therefore creating the synergy required to reach sustainable results.

Nonetheless, the feasibility of such interactions depends on the common purposes defined by these actors, in partnership with the involved sector, the support

institutions and the universities, to orient initiatives that address collective needs. Based on these, the advice to such associations and NGOs mainly regards their approaching the university, in order to investigate viable joint actions to be carried out in partnership with either a specific industry sector or the university (in particular, the Design School) or both. The effectiveness of such partnerships, in addition to minimizing social (and possibly environmental) problems, can contribute to generating new work opportunities as well as new economic resources.

10.3 Local Government

The local government's role as municipal manager, through which policies aimed at local development are created, is the reason that a partnership with the local government is relevant. In this sense, and in this case, the limited interaction between the local government and the furniture sector of Uberlândia/MG and with the university as well, limits the capacity to increase the positive impacts originated from such partnerships. There are many sectorial departments that operate in the City Hall's structure, mainly in isolated actions. An integration of actions not only among these specific departments but mainly between departments and external organizations can increase favorable impacts, if strategically oriented by a whole-system approach.

One of the aims of this work was, indeed, to demonstrate that it is crucial to join efforts from different types of organizations which can support the development of a territory. In the local Brazilian context it is still a challenging task, since none of the proposals presented to the several municipal departments that compose the Local Administration were supported by them. The challenge therefore lies in establishing a good level of communication that fosters the creation of design policies, which can then be implemented in a long-term program towards a sustainable new scenario.

Based on these reflections and on the gap among local government, the furniture sector and the university (specifically with the Design field), there is some advice to give.

- Promote joint actions with the industry in long-term programs considering the interdependence of people (at the individual and at the collective level), services and infrastructure, as well as the interdependence of actions that compose this system, to reach successful results;
- Open a new vision for the institutional management to deal with the challenging process of integrating an ICoN that supports the sustainable development of the region, as a whole;
- Favor occasions for interdisciplinary collaboration that permit the exchange of a contextualized knowledge among parties. This exchange is a strategic key to deal with complex real-life problems, then act to minimize gaps among science, industry operations and policies;

- Adopt new shared practices by motivating the diversity of pragmatic and scientific approaches, e.g. by combining various types of knowledge in developing programs and design policies to address sustainability, innovation and entrepreneurship, in particular in MSEs;
- Support the development of a Collaborative Design Pilot Project, but ensuring the real engagement of sectorial departments of the local government in order to trigger the evolvement of the involved sector and the beginning of a local change;

Encourage discussions about the networks of enterprises but considering the limitations of MSEs, thus providing them the necessary support for implementing actions and for improving skills which allow them to enter and remain in such networks.

10.4 Conclusion

Even though the pilot project and the arguments of this research were focused on a Brazilian context, they can be associated with other contexts, in either developed or in developing countries, with micro and small businesses in similar conditions and with fragmented design systems.

To stimulate innovation and local development, the ICoNs or the inter-organizational collaborative networks proposed by this research depend on a series of factors of different nature. They can be related to the group of partners that integrate them, the common goals defined collectively to assure commitment and trust and to detailed instruments of coordination. Furthermore, innovation depends on the circle of creation and re-creation of knowledge, in order to share and maintain a common understanding among the broad group that integrates any network. In this framework, it is fundamental that collaborative actions reserve space for discussing differences to balance interests and to construct a collective identity, therefore reducing the chances of what could be real interactions failing.

Considering innovation as a practice through which original ideas are developed and implemented by people connected in a particular context, aspects like paying attention to new needs and opportunities can represent difficulties in managing innovation. When these needs and opportunities are associated with demanding conditions, such as sustainability concerns, and become inserted in a contextualized and collaborative all-embracing system, the process of making new ideas well accepted and of dealing with part-whole relationships depicts quite a complex reality.

Such an image demonstrates the limits to creating infrastructures which are favorable for interaction and collaboration. On the other hand, and bearing in mind that isolated interventions are less efficient to deal with complex scenarios, it is necessary to combine solutions which are able to address different levels of communication and to test new ideas within this system formed by people, infrastructure and services, in order to reach more successful results towards balanced and sustainable scenarios.

Actually, the present research validates that not every partner—MSEs or other organizational types—can successfully be engaged in collaborative networks, as well as positively implement changes, whether technical or behavioral. There are several factors which affect the potential for change, which can be internal and external:

- Internal factors are mainly related to aspects such as enthusiasm, leadership, potential and ability for collaborating, awareness of specific internal problems but also of their interdependence with external factors, just to mention a few;
- External factors can be associated with issues such as the quality of the collaborative environment, i.e. the relationships established and maintained by such networks, the effective support that organizations obtain to operate in collaboration, the relations with market and consumers (in the case of business organizations) and the relations with social entities (in the case of associative and academic organizations).

In specific terms of technology, infrastructure and co-production aspects associated with the furniture sector in the region, the majority of local MSEs presented a low technological level. This condition leads to technical decrease, reflected in low productivity and lack of competitiveness. Nonetheless, the improvement of facility quality depends on the availability of financial resources, but also depends on the skilled knowledge that will guide to the acquisition of new machinery and permit its use.

In addition to the technological aspect, design awareness is quite challenging. While 72 % of the MSEs claimed they use design to develop furniture, it is not perceived as a key value of competitiveness and success for the company. This highlights the pressing need for diffusion of the design culture in the industry sectors in general, in order to improve both aesthetic and technical aspects as well as management issues by these MSEs.

The research reveals that some partners have feasible conditions to adopt new paths and collaborate towards a new scenario. However, there is a strong state of passivity in the local context regarding the furniture sector. This demonstrates that, notwithstanding those feasible conditions, it is essential that there be an entity or a manager that assumes leadership in partnership with the furniture sector by pushing participation among the different organizations and individuals. Such a presence could contribute directly to the continuous execution of actions and to maintaining the collaborative network.

Hence, in order to empower knowledge and increase skills, a network-building effort focusing on the creation, assumption and sustained execution of a set of ideas in the involved group is essential. The adoption of new sustainable concepts and new behavioral practices arising from the implementation of this inter-organizational collaborative network will require a great deal of energy and will occur over a long period of time. However, it is only through interconnections that these individuals and institutions will become properly committed to these ideas and act to turn them into reality.

Appendix A

A.1 The MP Assessment Tool

The five indicators and sub-indicators that compose the MP tool define the final profiles for the group analyzed. Additional tables to explain how to calculate each indicator, by using a percentage or an equation, are presented in the sequence. The data used to fill in the tables were based on: data regarding the facilities and equipment (from the questionnaires and SENAI's consultancies report); data on current use of materials, data on planned material; data of relations, meetings, shared actions (from the questionnaires and by monitoring the pilot process).

- *Environmental Indicator*: Related to both technical aspects and interaction issues, and a new way of dealing with products and processes, including selection, usage, maintenance, re-use/recycling, and disposal.

By using Table A.2, the four individual results of each aspect are calculated and then added in Table A.1. Further, the sum is divided by 4 (four issues) in order to get the average environmental indicator. To obtain the final result, the average is multiplied by 1.20 (index of indicator). This final value composes the Radar map.

The aspects included in Table A.2 are calculated based on the percentage of compliance to the enclosed issues described in items 1–4, as follows:

1. For each MDF panel (or other wooden or processed panels) to produce furniture is calculated the percentage of material used in relation to its total (100 %).
2. For each part remaining from use of the panels is calculated the percentage of reusing the material in other products that are already in production or in other planned productions.
3. Low impact process includes four aspects for analysis, which correspond to four levels of efficiency: (a) use of toxic-based chemical finishing materials; (b) use of a paint cabin when using toxic finishing materials; (c) use of air particle collectors during production; d) lighting and ventilation systems. The data used was based on SENAI's consultancies report (SENAI-CETAL/FAM 2012).

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Table A.1 Environmental Indicator

EvP	Environmental indicator—weight 0.2	Max. value
1.	Optimize consumption and minimize resources	100
2.	Re-use or re-cycle/product life cycle	100
3.	Adoption of low impact processes	100
4.	Use of certificated materials/components	100
	Total	400

Table A.2 How to calculate the environmental indicator

EvP	Environmental indicator	Levels of attendance			
1.	Optimize consumption and minimize resources				
	Regards the optimum use of material for producing a piece or a set of pieces of furniture	A*	B*	C*	D*
2.	Re-use or re-cycle/product life cycle				
	Regards the capacity for re-using useful waste within or outside the company, for production of new pieces (1)	A*	B*	C*	D*
3.	Low impact process				
a.	Use of finishing products with chemical base	A*	B*	C*	D*
b.	Use of a paint cabin for controlling dispersion of toxic particles in the air (employees' safety/ hazardous impacts)	A*	B*	C*	D*
c.	Use of an air particle collection system during production	A*	B*	C*	D*
d.	Use of lighting and ventilation systems				
	Natural (50 % lighting + 50 % ventilation)	A*	B*	C*	D*
	Artificial (50 % lighting + 50 % ventilation)	A*	B*	C*	D*
4.	Use of certificated materials				
	Regards the (gradual) substitution of toxic materials for other safer non-pollutant materials				
	a. MDF, other wooden panels or derived-	A*	B*	C*	D*
	b. Finishing ————————	A*	B*	C*	D*

A* 0–25 % (insufficient); B* 25–50 % (low); C* 50–75 % (medium); D* 75–100 % (high)
(1) This does not intend to stimulate a production increase. However, in the case of a continuous furniture production, the reuse of small pieces of MDF (or other components used by the MSE) could reduce the final waste generated by such production

4. Use of certified materials. The proportion (0–100 %) was calculated based on the average monthly production, how many manufactured products were finished by using such materials in relation to the total monthly production.

- *Technological Indicator*: Related to the improvements through adopting sustainable design concepts and implementing collaborative practices, to improve quality, increase knowhow and optimize infrastructure during production.

Table A.3 Technological indicator

TeP	Technological Indicator—weight 0.25	Individual value
1.	Adoption of low cost x better production capacity	Vte
2.	Facilitate assembly/disassembly and adaptability	100
3.	Share design processes	100
4.	Share production processes	100
	Total	

By using Table A.4, the individual results of aspects 1 and 2 are calculated; then, they are reported to the Table A.3 and multiplied by their individual weights. Further, the four individual values are then added and divided by 4, in order to get the average technological indicator. To obtain its final result, the average is multiplied by 1.25 (index of indicator). The final value composes the Radar map.

With respect to each closed issue of this indicator it is important to point out

1. The 'technological value' combines values from design (given by the reduction of variation among parts), time for manufacturing, material costs and time costs.*
2. This refers to the flexibility of joining systems that could simplify the assembly and/or disassembly of a product, also allowing the substitution of defective parts.*
3. This issue only measures the "share of design processes" in quantitative terms. It was calculated based on how many times, during a new product creation, there is an exchange of design solutions with the other mentioned actors. The quality and effectiveness of interactions were not evaluated due to the need of other accurate criteria and data as well as of broad detailing of all aspects to be considered.**
4. The "share of production processes" was calculated in quantitative terms, based on how many times the MSE shares machinery with another company in order to optimize production (time and labor).

*The data used was based on MSE information and by monitoring the prototyping phase

**The data used to obtain this indicator was based on both the analysis of questionnaires and on project development monitoring

- *Socio-cultural Indicator*: Refers to the continuous learning process, to improve competencies and reach common results, decisive for successful innovations.

By using the Table A.6, the individual results of aspects 1 and 2 are calculated. Then, they are reported to Table A.5 and multiplied by their individual weights. The two values are then added and divided by 2 (average of socio-cultural indicator). To obtain its final result, the average is multiplied by 1.20 (index of indicator). The final value composes the Radar map.

Table A.4 How to calculate the technological indicator

TeP	Technological indicator				
1.	Low cost production x better performance, calculated by Vte (technological value) = [B] ÷ [C] a. Benefit: refers to the reduction of variation in parts' dimensions, increasing the capacity for combining elements (standardization/modularity), increasing the flexibility of composition, reducing lead time of production, material and costs. The value is given by a percentage of standardization of a piece of furniture (for example, 30 %). This value is adopted as reference for an "index of standardization" (), in the case of this example = 30 (the percentage is transferred to the numeral scale to align with other values) Equation of benefit: B (benefit) = $(iS)^2$				
	b. Cost: refers to the time of production, to the costs of working hours and to the costs of material. Equation of Cost: C (Cost) = Tc + Cm Where: Tc (Time of production) = Qh (Quantity of working hours) × Ch (Cost by hour) Cm = Costs of material C (Cost) = Tc + Cm How to calculate the Technological Value (Vte) Vte = [B] ÷ [C] B(benefit) = $(iS)^2$ C (Cost) = Tc (Qh × Ch) + Cm				
2.	Facilitate assembly/disassembly and adaptability				
	Refers to the use of flexible fixing systems (connections) that permit: easy assembly/disassembly; addition of new parts or substitution of broken parts, without damaging original structure	A*	B*	C*	D*
3.	Share design processes				
	Regards the several interactions (MSEs/ suppliers/ government/university/institutions/professionals) to discuss design solutions (project and production)	A**	B**	C**	D**
4.	Share production processes				
	Refers to the interaction among companies to increase capacity of production by optimizing machinery usage.	A***	B***	C***	D***

A* 0–25 % (insufficient); B* 25–50 % (low); C* 50–75 % (medium); D* 75–100 % (high)
A** 0–25 % (insufficient); B* 25–50 % (1–3 times, low); C* 50–75 % (4–6 times, medium); D* 75–100 % (7–10 times, high)
A*** 0–25 % (0–3 times/each 6 months, insufficient); B* 25–50 % (4–10 times/each 3 months, low); C* 50–75 % (11–15 times/each 2 months, medium); D* 75–100 % (16–20/each month, high)

Table A.5 Socio-cultural Indicator

ScP	Socio-cultural indicator—weight 0.2	Individual value
1.	Improve skills and awareness	100
2.	Developing products and/or services to address social interests (e.g., low income consumers, social bodies, schools, and others)	100
	Total	200

Table A.6 How to calculate the socio-cultural indicator

ScP	Socio-cultural indicator	Levels of attendance			
1.	Improve skills and sustainability awareness				
	Regards the positive effect of collective developed actions. To calculate: If knowledge shared with Pilot Project				
a.	Improved the production process	A*	B*	C*	D*
b.	Opened other possibilities of production	A*	B*	C*	D*
c.	Increased skills in dealing with their own company	A*	B*	C*	D*
d.	Increased skills in dealing with other companies	A*	B*	C*	D*
e.	Increased awareness with internal problems related to				
e.1.	Environmental aspects	A*	B*	C*	D*
e.2.	Organizational aspects	A*	B*	C*	D*
e.3.	Technological aspects	A*	B*	C*	D*
2.	Developing products and/or services to address social interests				
	Regards the delivery of better products and/or services to low income customers, partnerships with schools, NGOs, and others	N	L	M	H

A* 0–25 % (insufficient); B* 25–50 % (low); C* 50–75 % (medium); D* 75–100 % (high)
N No delivery (zero); *L* Low delivery (25 %); *M* Medium delivery (50 %); *H* High delivery (>50 %)

The data used to fill out the Table A.6 was based on the MSEs' information.

1. Specific aspects that compose issue 1. 'improve competencies and sustainability awareness' were calculated in quantitative terms (percentage), but based on the MSEs' perceptions in relation to each detailed item (from 'a' to 'e') in Table A.6.
2. This issue focused on the existence of any relation between MSE and any actor or initiative meant to respond to a social concern. It was measured in quantitative terms, in relation to existing ties with the aforementioned actors. Each established (and current) relationship represented 25 % of the totality of the issue.

- Economic Indicator: Related to the increase of the organization's production capacity and competitiveness.

The individual results of aspects 1 and 2 are calculated by using the Table A.8, then inserted in Table A.7 and multiplied by their individual weights. The two values are then added and divided by 2 (average of the economic indicator). To obtain the final result, the average is multiplied by 1.20 (index of indicator).

Table A.7 Economic indicator

EoP	Economic indicator—weight 0.2	Individual value
1.	Increase production	100
2.	Increase competitiveness	100
	Total	200

The issues that compose this indicator are described in Table A.8. Data on the time spent to produce the furniture, used in calculations, were based on the MSEs' information (current production) and the prototyping phase (pilot project) . Even though the variables do not cover the wide range of aspects involved in an analysis of competitiveness, the indicator worked as one of the alternatives to know a possible gain for the MSE, in the case of a change in its approach to production.

- **Organizational Indicator**: Refers to the capacity of connecting dissimilar actors to work collectively as a platform to create products and/or services and to share knowledge and information within the involved group and with outside entities.

By using the Table A.10, the two individual results of aspects 1 and 2 are previously calculated. Then, they are inserted into Table A.9 and multiplied by their individual weights. The two values are then added and divided by 2 (organizational indicator average). To obtain its final result, the average is multiplied by 1.15 (index of indicator). The final value composes the Radar map.

The issues included in this indicator are mainly based on MSE perceptions in relation to the aspects mentioned. Based on their current practices and the experience with the Pilot Project development, they indicated the values used to fill in the table and to calculate the final results of the organizational indicator. Values included to calculate issue 1 comprise items a, b, c, d, e, f, g and h. Values included to calculate issue 2 comprise items a, b, c, d, e, f, and g. Each item, individually, composes the final value of issue 1 and issue 2.

Table A.8 How to calculate the economic indicator

EoP	Economic indicator
1.	Increase production capacity
	Regards the increased capacity of production. The aim is to understand if the proposed design of artifacts helps either increase the volume of production or facilitate the production process Vpr = production volume T = time of production (in hours) Vpr = Npieces × (50i) ÷ T ⇒ Vpr = 50 ÷ 50h ⇒ Vpr = 1
2.	Increase Competitiveness
	Regards the capacity to deal with demands. If the capacity of production increases through cost reduction, the competitiveness can increase. The competitiveness Value (Vco) is calculated by the sum of the technological value (Vte) and the production value (Vpr) Vco = Vte + Vpr

Table A.9 Organizational indicator

OrP	Organizational Indicator—weight 0.15	Individual value
1.	Connection between actors/enabling platforms	100
2.	Sharing knowledge and information	100
	Total	200

Table A.10 How to calculate the organizational indicator

OrP	Organizational indicator	Levels of attendance			
1.	Connecting actors				
	Refers to the interaction among partners with different and/or similar roles and competencies, to act in collaboration. Partnerships established with different actors	A*	B*	C*	D*
		0–3 times/ every 6 months	4–10 times/ every 6 months	11–15 times/every 3 months	11–15 times/every 3 months
		Insufficient	Low	Medium	High
a.	Educational institutions	A*	B*	C*	D*
b.	Support institutions	A*	B*	C*	D*
c.	Local government	A*	B*	C*	D*
d.	NGOs, local associations	A*	B*	C*	D*
	Partnerships established with similar actors	A*	B*	C*	D*
e.	Companies (same field)	A*	B*	C*	D*
f.	Companies (different field)	A*	B*	C*	D*
g.	Suppliers	A*	B*	C*	D*
h.	Stores	A*	B*	C*	D*
2.	Share knowledge and information				
	The perceived value and the significance of effective connections, for acquiring knowledge and accessing new information, based on MSEs involved	A* Insufficient	B* Low	C* Medium	D* High
a.	Meetings	A*	B*	C*	D*
b.	Prototype phase production	A*	B*	C*	D*
c.	Prototype phase discussion	A*	B*	C*	D*
d.	Prototype phase exhibition	A*	B*	C*	D*
e.	Consultancies	A*	B*	C*	D*
f.	Research support	A*	B*	C*	D*
g.	Working together	A*	B*	C*	D*

A* 0–25 % (insufficient); B* 25–50 % (low); C* 50–75 % (medium); D* 75–100 % (high)

A.2 Mapping the MSEs' Profiles

The Radar Map tool was adopted to provide a visual communication of the final values found in the tables of indicators. In order to classify the MSEs' existing conditions as well their level of change after the MODU.Lares Project experience, the values found in Tables A.1, A.3, A.5, A.7, and A.9 must be inserted into Table A.11, according to the results of the calculated indicators. Then, for the already known indicator values, it is necessary to calculate the simple initial average (*Ai*) of results (sum the five final values of indicators and divide the sum by the number of indicators, in this case, five) and enter it in Table A.11, column (*Ai*).

The profiles were divided in five main levels (A, B, C, D and E), and four transition levels (T-AB or T-BA; T-BC or T-CB; T-CD or T-DC; T-DE or T-ED). They indicate the level of the MSE's operations, in terms of best performances regarding the issues approached by the indicators.. The higher the MSE's level [i.e. from E (lowest) to A (highest)], the better is its performance and, thus, its profile.

The values from the final tables of indicators in Table A.11 must be gathered, at most, in three lines, i.e. two main levels (e.g. A, B, C, D and E) (and one transition level, e.g. BA, CB, DC, ED) or two transition levels (and one main level), including the initial average (*Ai*). At this point, it is necessary to select at least four values (corresponding to the indicators, which can include or not the initial average [*Ai*]). Then, the final average (*Af*) that defines the MSE profile is calculated from the values gathered (sum of four values and its division by four). In those cases where all indicators are inserted into the selected area (i.e. two main levels or two transition levels, as explained above), then, the final average (*Af*) will correspond to the initial average (*Ai*).

How to use Table A.11, to define the MSE profile: After insertion of the final indicator results, and their gathering according to the procedure described above, the four values remaining in the selected area are summed up and divided by 4 (to obtain the final average [*Af*] that will indicate the MSE's profile):

Hence, calculating with the data before the intervention:

- *Ai* (initial average) with the values of indicators previously calculated:

$$Ai = \frac{\text{EvP} + \text{TeP} + \text{EoP} + \text{ScP} + \text{OrP}}{5} \rightarrow Ai = (55 + 48 + 10 + 27 + 20)/5 = 32 \rightarrow Ai = 32$$

- *Af* (final average), with the gathered values:

$Af = \frac{\text{EoP} + \text{ScP} + \text{OrP} + \text{Ai}}{4} \rightarrow Af = 10 + 27 + 20 + 32 = 89/4 = 22.5$ (Transition level ED)

Hence, calculating with the data after the intervention:

- *Ai* (initial average): $100 + 92 + 40 + 52 + 67/5 = 70.2 \rightarrow Ai = 70$
- *Af* (final average), with the values gathered:

$$Ai = \frac{\text{ScP} + \text{OrP} + \text{Ai} + \left(\frac{\text{Ai}}{2}\right)}{4} \rightarrow Af = 52 + 67 + 70 + (70/2) = 224/4 = 56$$

(Level C) (see the explanation of this equation in Case 2, below)

Three other possibilities for gathering the results were identified. If Table A.11 presents one of these conditions, the calculation of the MSE profile must occur according to the following indications:

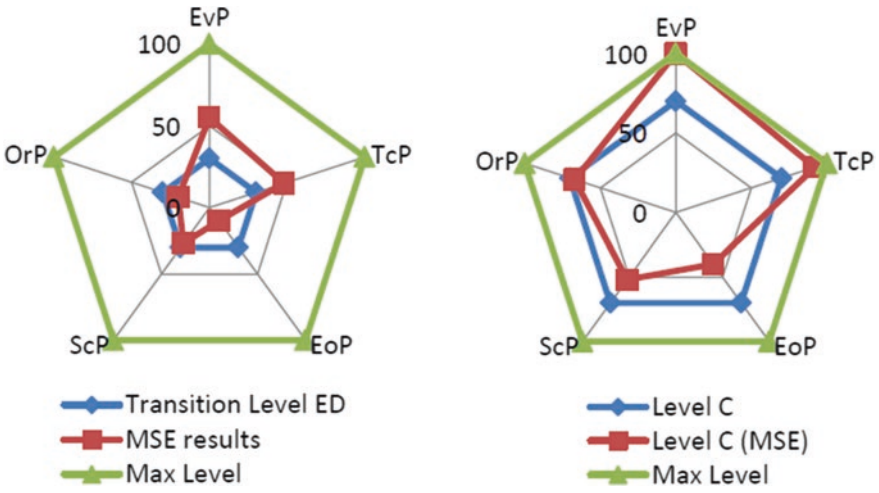
Case 1: When Table A.11 presents only three indicator values possible to gather as said before (in three lines), then the initial average (*Ai*) is included in the sum, in order to calculate the final average (*Af*), i.e. the definition of the firm's Profile.

Table A.11 Example of an MSE profile

Level	Values	Indicators Before*							Indicators After**						
		EvP	TeP	EoP	ScP	OrP	Ai		EvP	TeP	EoP	ScP	OrP	Ai	
E	0 - 25			10		20									
Transition ED	25 -30				27			Af							
D	30- 45						32				40				
Transition DC	45- 50		48												
C	50- 70	55										52	67		Af
Transition CB	70- 75													70	
B	75- 85														
Transition BA	85- 95									92					
A	95-100								100						
Final Level		Transition LEVEL ED							LEVEL C						

*Indicator Before means the assessment of MSE at the beginning of the project (June, 2011), based on the analysis of questionnaires (June, 2011), and data from MSEs.

**Indicator After means the assessment of MSE after the intervention, prototyping, and exhibitions (June, 2012), based on the analysis of questionnaires (June, 2012), data from MSEs, data from SENAI's report (SENAI-CETAL/FAM, 2012).



Graph A.1 Radar map (illustration of profiles)

Case 2: When Table A.11 presents only two indicator values possible to be gathered as said (in three lines), then, by using as reference the value of the initial average (*Ai*), an auxiliary value must be provided. This auxiliary value (*Av*) should be represented by the half part of the total *Ai* (e.g. $Ai = 70$; $Av = 35$). This will permit the generation of the last value to be summed, and to calculate the final

average (*Af*) that, hence, will define the enterprise's Profile (this situation is demonstrated in Table 2.1, data after intervention).
Case 3: When Table A.11 presents only one indicator value (or two, already including the average *Ai*), in this case there is a veto. This means that is not possible to classify an enterprise according to a Profile due to its heterogeneity of values.

Further, in order to clearly visualize the referred Profiles, a Radar Map is created by using the final values (i.e. indicators) resulting from the calculations (Table A.11), as shown in Graph A.1.

From the Radar Map it is possible to see that in both analyses, the MSE fits into the pre-defined profiles (i.e. three indicators are inside the borders of the level boundaries) . It is worth highlighting that there are many other aspects that can be included in such an analysis, to be more accurate. However, within the scope of this research it was a useful tool that helped to visualize the MSEs' current situation and to identify some change generated from the pilot project implementation.

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