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Human Resource Management Practices in Lean Production – The Role of Manufacturing Strategy Goals

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Doctoral Thesis

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Introduction

Researchers in the field of Operations Management (*OM*), as well as Human Resource Management (HRM) have already realized that real-life phenomena necessitate a complex approach, namely the cooperation of these two fields of sciences. **Operations Management**, however, still focuses its efforts on the hard aspects (e.g. technology, capacity, inventories, performance effects etc.), and **knows little about the soft factors**. Studies typically „*ignore or under-emphasize the 'soft' issues related to people, teams, accountability, culture, motivation and discipline*" (Samson and Whybark 1998, p. 4). All this despite soft factors – not just jointly, but any one of them individually – having a critical role in the success of manufacturing concepts.

The above statement seems to be right the other way round, as well: during the 1990s, the HRM literature was criticized by a number of authors from the Operations Management (Jayaram, Droge, and Vickery 1999) and lean production (MacDuffie 1995) fields for having paid too little attention to manufacturing concepts. Which happened in spite of people management innovations (Wood 1999) and the special role of HRM within the organization (managerial attention, financial support) both having originated in production (Pfeffer 1997; Subramony 2009).

Even though there is great potential in linking Operations Management and HRM (Boudreau et al. 2002; Moyano-Fuentes and Sacristán-Diaz 2012), the criticism is still justified: it is only a very few authors who deal with the intersection of these two scientific fields. My research links the two disciplines through the lean production system.

The human resource perspective has been present in the literature of the lean production system from the very beginning, the end of the 1970s. The depth and focus of studies has varied greatly ever since. Early works of research paid an equal amount of attention to the infrastructure (including HRM) that supports the production system and the technical practices of manufacturing (Sakakibara et al. 1997). Sugimori et al. (1977), who were the first to report on Toyota's production system, gave special emphasis to the significance of human resources, and underlined that *respect for people* is one of the pillars of the Toyota Production

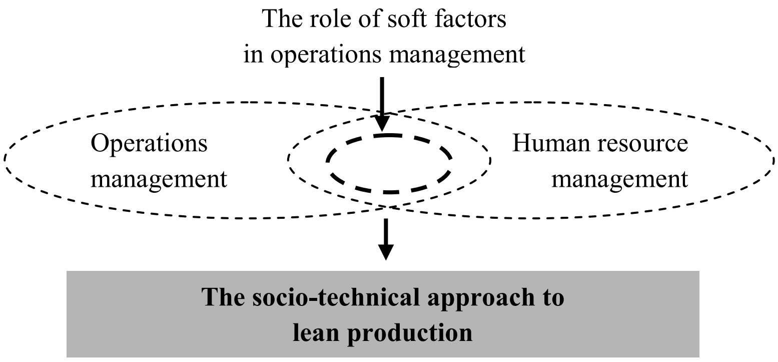
System. As early as 1985, the impact of cell production on employees was already being investigated (Huber and Hyer 1985). Later on, the focus of lean production research shifted to technical practices. In spite of this shift of emphasis, authors do not fail to point out that the lean system can only function efficiently if it is supported by factors like organizational structure, organizational culture, changes in employee and management roles and styles, new communication channels and Human Resource Management practices. As regards these soft factors, however, they rarely get any further than merely raising the issue or drawing anecdotic conclusions.

Even though Human Resource Management is a diverse field (Bakacsi et al. 2000), it is quite common in the Operations Management literature to talk about Human Resource Management practices while actually referring to the work organization practices of high performance work systems only. In this regard, my thesis will be similar to Operations Management studies, and – in keeping with the somewhat questionable tradition – use the two concepts as synonyms.

An indication of a close relation between lean production and HRM is that the **socio-technical approach to lean production** has for long been present in the literature, which is the very approach my research is built upon. According to this approach, apart from the technical elements (technical subsystem), HRM practices (socio subsystem) are also part of the lean production system (Shah and Ward 2003).[1] Figure 1 provides a summary of the line of thought we have followed so far.

[1] Despite significant differences between the two, a number of authors dealing with lean production treat, in my opinion, the socio-technical approach and socio-technical theory as one and the same thing. Without going into details, what I would like to emphasize here is that the goals associated with the two concepts are different. According to the socio-technical approach, it is socio (HRM) and technical (manufacturing) elements together that yield results, expressed in terms of business or operational performance indicators. In socio-technical theory, the primary goal is to improve the autonomy, independence and responsibility of the workforce – in addition to which the firm's profit might be an important aspect, as well. The comparison of lean production and socio-technical theory is discussed by Niepcel and Molleman (1998), and MacDuffie (1995) touches upon the topic, as well. For an overview and criticism of the two systems also see Moldasch and Weber (1998). With the above in mind, my position is that the lean production system ought to be discussed applying the socio-technical approach.

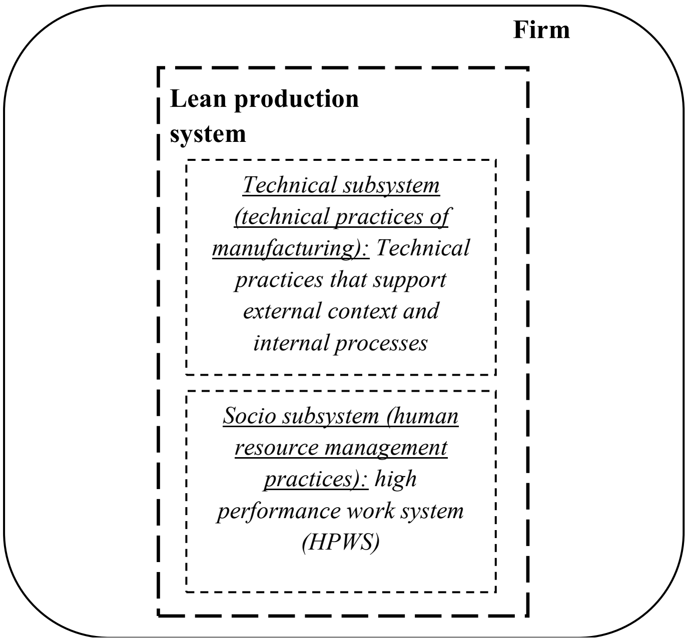
Figure 1. The connection of the present study with Operations Management and Human Resource Management



The socio-technical approach to lean production unites – theoretically – the best practices of the two functions. Manufacturing – the **technical subsystem –** is built upon process orientation, *pull production*, the *just-in-time* (*JIT*) principle, quality management, maintenance or supplier and customer relationships. HRM – the socio subsystem – is characterized by the practices of the **high performance work system** (HPWS)[2], e.g. involvement, teamwork, rotation, training, multi-skilled workers etc. The structure of the socio-technical lean production system, as detailed above, is shown in Figure 2.

[2] In addition to HPWS, the literature also uses several other terms: alternative work practices (Gittleman, Horrigan, and Joyce 1998; Godard 2000), new practices of work organization (Cagliano et al. 2011), *high-involvement practices, high-commitment practices*, HRM best practices (Legge 2006; Pfeffer 1998; Pfeffer and Veiga 1999). My thesis uses the HPWS abbreviation. One should be aware, nevertheless, that the phrase 'HPWS' implies a meaning that it does not necessarily carry (e.g. Gittleman, Horrigan, and Joyce 1998), e.g. HPWS is not certain to further business performance,nor to positively affect employee commitment or the employees themselves. This problem will be discussed in Chapter 4.

Figure 2. Structure of the lean production system



Beginning with the mid-1980s, numerous studies have looked into the role that HRM practices have in lean production. These papers dealt with the

- empirical investigation (can the presence of HPWS practices be verified?),
- intensity of use (which HPWS practices are more characteristic for lean production?), and
- efficiency (do HPWS practices contribute to operational performance?)

of the HRM practices that appear in lean production.

Despite the increased interest observed during the last couple of decades (Forza 1996; Harrison and Storey 1996; MacDuffie 1995), large-sample studies have still remained scarce to date (Birdi et al. 2008; de Menezes, Wood, and Gelade 2010; Dabhilkar and Ahström 2013). Findings exhibit remarkable variance, too: some suggest a very close relationship between the two subsystems, while others regard the use and efficiency of HPWS practices in lean environments as debatable at best. It remains unclear, furthermore, what the improved performance of lean producers originates from: the technical elements, the socio elements or the two of them together? My research is aimed at clarifying these questions and contradictions.

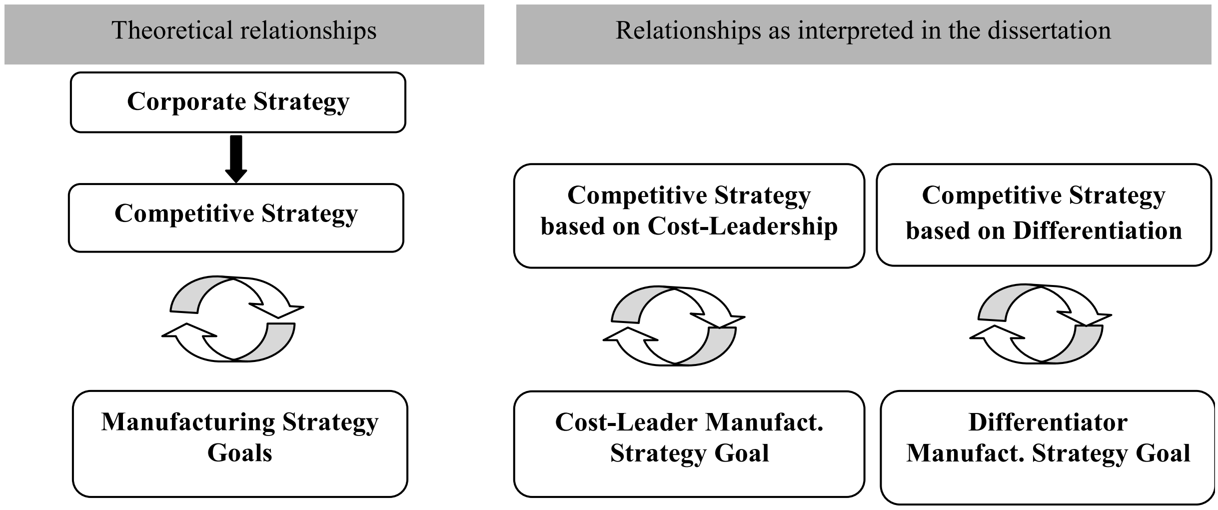
The focus of my large-sample study is to develop a better understanding of the role that socio elements have in the lean system. **With respect to previous research,**

my work is original in the regard that it removes the assumption that the lean system is context-independent. Operations Management researchers – sometimes explicitly, but most of the time implicitly – consider the lean system to be a „closed system". Which in turn means that the context usually receives no attention at all: **the effects that external (e.g. business environment) and internal (e.g. strategic goals, manufacturing characteristics) factors have on the lean system** are unknown. It needs to be clarified how the lean production system might be affected by factors like the business environment, the age and size of the firm, its nationality, culture, functional and strategic goals, the nature and complexity of its processes.

The focus of my thesis is the socio subsystem of the lean production system, and its relation with manufacturing strategy goals. The manufacturing strategy goal concept used in this thesis corresponds to the generic strategy approach of the Operations Management literature (see Demeter 2000). The reason why doing away with the context-independence of the lean system and examining the role of (manufacturing) strategy goals appears promising is that the HRM literature suggests that strategic goals may have a significant influence on HRM practices (including HPWS practices, as well). That is, strategic goals affect the lean system through its socio subsystem.

For the purposes of the present research, manufacturing strategy goals will be assigned to the two sources of competitive advantage as identified by Porter (cost-leadership, differentiation). In Operations Management, the manufacturing strategy goals associated with these two sources of competitive advantage are, in analogy to the Porter Ian terms, referred to as cost-leader and differentiator manufacturing strategy goals (Frohlich and Dixon 2001, Hallgren and Olhager 2009). Drawing from Miller and Roth (1994), manufacturing strategy goals will be captured by means of the plant's order-winning criteria. (In the present dissertation, I will not always specify the organizational level the strategic goals of which I am referring to, but simply write 'strategic goals' instead.) Corporate strategy has an extremely complex conceptual background. As far as the present thesis is concerned, I do not intend to discuss the concept in detail, nor to present its areas of decision-making (e.g. industry positions). My research questions are based on the relation between the sources of competitive advantage and manufacturing strategy goals.

Figure 3. Strategic goals and their presence in the organization – the framework applied in the thesis



Source: based on Slack and Lewis (2011, 2)

Even if we limit our scope to the cost-leader and differentiator manufacturing strategy goals only, there have been significant changes in their contents during the last couple of decades (e.g. impact of the crisis). Therefore **Research Question 1 of my thesis aims at exploring how the cost-leader and differentiator manufacturing strategy goals should be interpreted in the end of the 2000s, based on our sample of manufacturing firms** (Figure 4).

The relationship between the socio subsystem of the lean production system and manufacturing strategy goals is the subject of Research Questions 2 and 3. **I will investigate on our subsample of lean manufacturers whether there is a difference in…**

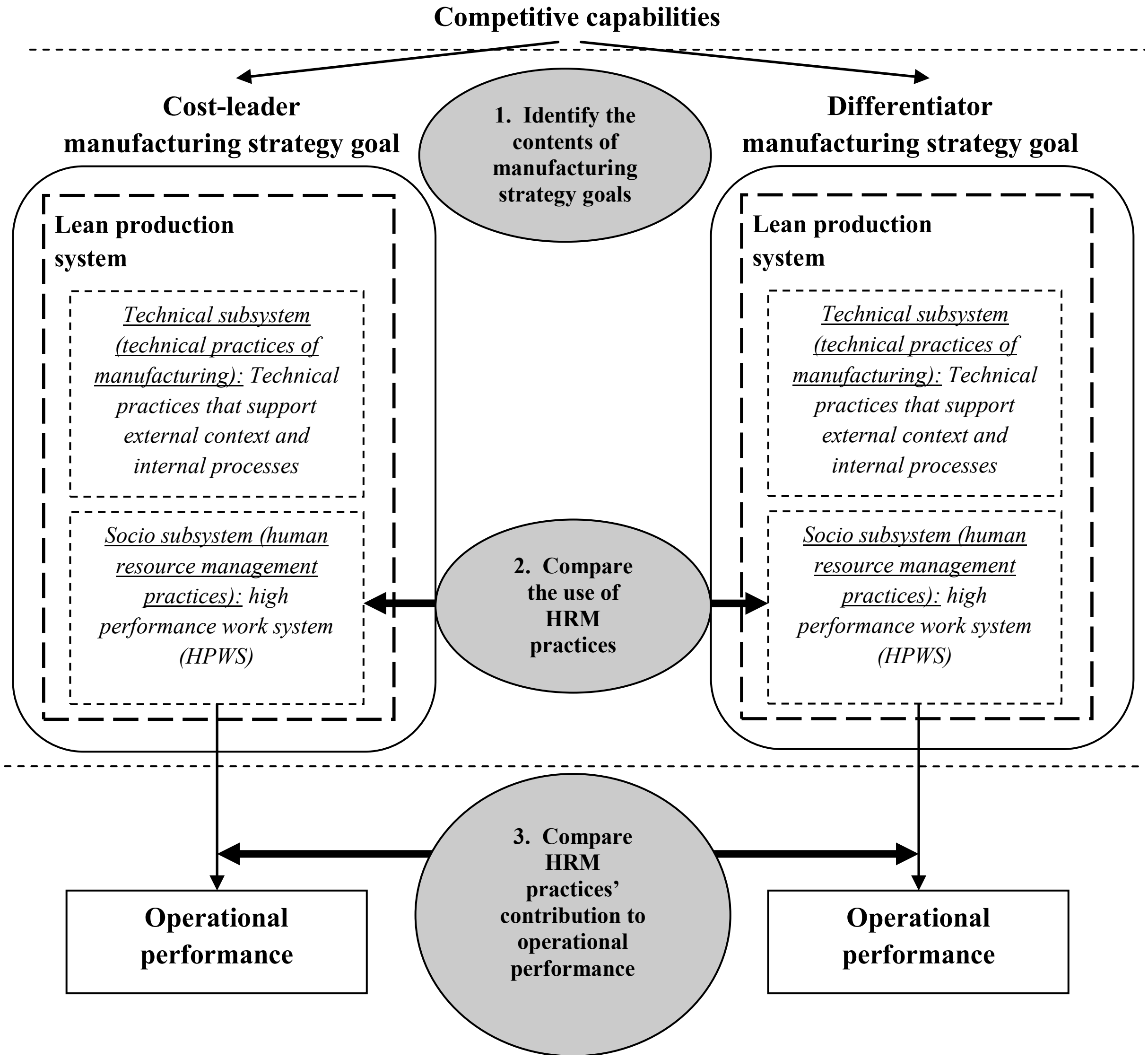
Research Question 2: the use of HPWS practices

Research Question 3: the effect that HPWS practices have on operational performance

by manufacturing strategy goal.

The research questions are represented by the gray horizontal ellipses in Figure 4. **I assume that it will be possible to identify the two manufacturing strategy goals, and that the different manufacturing strategy goals will be accompanied by differing configurations of the lean production system – and the HRM system within – and differing operational performance effects.**

Figure 4. Structure of the lean production system and the research questions



Why and how is the socio subsystem of the lean production system different under differing manufacturing strategy goals? That question can be answered by working along the various approaches to the relationship between strategic goals and HRM practices, of which three will be presented here:

- **Best practice**. This approach builds upon the assumption that it is the adaptation of the best practices, i.e. HPWS practices, that leads to superior performance. The **impact of strategic goals and the business environment of the given firm is marginal** with respect to both the use of HPWS practices and their performance effects (Huselid 1995). (in Operations Management e.g. Voss 1995.) The empirical literature on lean production is dominated by the best practice approach. That is, distinguishing between lean producers by manufacturing strategy goal is of no significance: **each and every lean producer strives for the adaptation and intensive use of HPWS practices.** It is the aspiration to better understand the impact of contextual factors that leads us to the other approaches.

- **Best fit.** The approach assumes that it is only the HRM practices that correspond to the source of competitive advantage at hand that positively contribute to operational performance. It **associates the different sources of competitive advantage with different work organization practices: HPWS practices are highly compatible with a differentiation strategy, but hardly or not at all compatible with cost-leadership as the source of competitive advantage.** The cost-leadership strategy is associated with the traditional (a type of Taylorist) way of work organization. Which gives rise to doubts about the use and the contribution to operational performance of HPWS practices with regard to firms that are cost-leaders.

  My literature review uncovered one single study that employs the best fit approach and is directly related to modern production systems (Youndt et al. 1996). (With respect to Operations Management, this approach resembles the strategic choice paradigm, see Voss 1995. For a discussion of contingencies in Hungarian, see Dobák (2006) and Dobák and Antal (2010)).

- **Synthesizing approach**[3]. The synthesizing approach is the „combination" of the former two approaches. It equates HRM practices with HPWS practices (best practice) and underlines that competitive strategy does have an impact on HPWS practices (best fit). **According to this approach, differentiation is accompanied by the intensive and efficient use of HPWS practices, while cost-leaders typically make less intensive and less efficient use of them**.

  A number of studies included in my literature review seem to support the supposition that this approach can actually be applied to the lean production system.

Figure 5 provides a summary of the above-mentioned approaches, highlighting the HRM practices appearing in each approach and the assumed relationships between the sources of competitive advantage and HRM practices. More than one approach appears to justify the expectation that **strategic goals might have an**

[3] The term 'synthesizing approach' was coined by myself, and it serves to distinguish this perspective from the other two approaches. By this phrase, I wish to emphasize that it is focused on examining the fit of best practices.

important role in the socio subsystem of lean production: in comparison to lean producers with a differentiation strategy, those with a cost-leadership strategy make less intensive use of HPWS practices and the effect of HPWS practices on operational performance is weaker for the latter group, as well.

Figure 5. The relationship between HRM practices and competitive strategy goals

Studies with an HRM focus			
Approach	**Best practice**	**Synthesizing approach**	**Best fit**
HRM practices	HPWS	HPWS	HPWS and traditional
The impact of strategic goals on the intensity and efficiency of the use of HRM practices	Context independent (universal), no significant impact	Differentiation as a source of competitive advantage is expected to be accompanied by a more intensive and efficient use of HPWS practices than cost-leadership	Differentiation as a source of competitive advantage is expected to be accompanied by an intensive and efficient use of HPWS practices, whereas cost-leaders use traditional practices

Originality and Value

The analysis of the relationship between (manufacturing) strategy and the lean production system is indeed a current topic – one that has received scant attention, nevertheless (Hines, Holweg, and Rich 2004). And this still is the case today, even though several renowned researchers have called for increased efforts in recent years' mainstream lean literature (Batt 2007; Sakakibara et al. 1997; Shah and Ward 2003).[4] Thus it hardly comes as a surprise that strategy gets very little attention in the socio-technical approach, as well. The focus I opted for is also closely related to the trend observed in Operations Management research: the analysis of the relationship between contextual factors (contingencies) and production concepts is becoming more and more the center of attention (Matyusz 2012; Sousa and Voss 2001; Sousa and Voss 2008).

[4] It is not always clear, however, what these authors mean by manufacturing strategy.

The contribution of my research to the field of Operations Management, with respect to the academic discourse on the lean production system, is manifold:

- It takes a differentiated approach to lean producers. For the most part, Operations Management studies compare lean producers to traditional producers or assess the extent of application of the lean system. The present work only considers lean producers, yet treats them in a differentiated fashion.
- The linking of manufacturing strategy goals with the lean production system make for a novel research framework.
- It adds to the large-sample Operations Management studies that follow the socio-technical approach to lean production.
- It integrates the above three attributes. Whereas it is quite common in the HRM literature to look into the effect that strategic goals have on HRM practices, I know of no example where manufacturing strategy goals and the use and efficiency of HRM practices have been investigated in a lean environment.

The findings do have practical implications, as well. Based on the answers to my research questions, recommendations may be formulated as to which HPWS practices, depending on the manufacturing strategy goal pursued, managers should concentrate on developing.

Research Paradigm and Perspective

Operations Management – and the works dealing with lean production within – basically employs the functionalist paradigm. The assumptions and methodology of my thesis are rooted in functionalist logic. Apart from positioning itself, the present dissertation will not discuss the characteristics of the different research paradigms[5] (Burrel and Morgan 1979; Gelei 2006). The research questions will be investigated

[5] The word paradigm is used in different senses in different parts of the dissertation. This paragraph is about research paradigms. Previously I mentioned manufacturing strategy paradigms, referring to the set of assumptions based on which production becomes a coherent subsystem of the firm's operation. Later, when discussing the literature of lean production, the concept of paradigm will serve to describe the fundamental differences between the traditional production system and the lean system. The concept of paradigm bears completely different meanings in the different parts of the thesis. Whichever individual paradigm concept we consider, however, it certainly has a much more narrow focus than the definition used in theory of science as derived from Kuhn (2002).

by testing hypotheses formulated on the basis of the literature review, i.e. I will follow the deductive method (Babbie 2008; Vicsek 2006).

Work organization practices may be considered from a number of perspectives. Dohse et al. (1985) classify studies dealing with Japanese work organization systems (Toyotism) into four groups. The researchers either employ a

- cultural,
- *human relations* or
- production control point of view, and there exists an
- integrated explanatory approach, as well, to eliminate the deficiencies of the above-mentioned three individual perspectives.

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These research perspectives reflect the researcher's choice from among the mechanisms along which the lean system is organized. Operations Management – and hence my thesis, too – applies the production control perspective. This research perspective gives prominence to the technical dimension of process organization. From a production control perspective, the lean system's technical practices of production constitute a 'hard' element, while HRM practices are considered to be a 'soft' component.[6]

<u>Structure of the Thesis</u>

Having reviewed my research questions, research paradigm and research perspective, the Introduction is concluded with an overview of the focal points of the literature review and the dissertation's structure.

The structure of the thesis is illustrated by Figure 6.

Chapter 1 of the dissertation **introduces the lean production system**. It provides a brief overview of the main stages of development of lean management and of the problems about the lean system's interpretation. The proposed definition reflects the socio-technical approach.

[6] Nevertheless, the HRM practices that my thesis treats as a soft element are often depicted as a hard factor in the HRM literature. It should suffice to recall that I assume HRM practices to be measurable. This problem falls far beyond the scope of the present dissertation.

Chapter 2 presents the theoretical model of the socio-technical approach to the lean production system. The adapted theoretical model is called the concept of the lean production system's organizational logic.

From the body of research into the socio-technical system of lean production, Chapter 3 discusses those works that examine the intensity and efficiency of use of the HRM practices employed by lean producers**.** Even though these papers are dominated by the best practice approach, the chapter devotes attention to authors' conclusions concerning strategic goals, as well. Basically, this part of the thesis is a detailed review of the large-sample empirical studies that cover both socio and technical practices (and, in some cases, operational performance, as well).

The focus of Chapter 4 is HPWS practices – a central element of lean production. It is a review of the part of **Operations Management and HRM literature** that deals with the relationship between strategic goals and HPWS. Also, Chapter 4 mentions in brief the external (environmental) factors that are often brought up in connection with HRM practices, yet still represent the limitations of my present work.

Chapter 5, based on Chapters 2, 3 and 4, identifies strategic goals' potential effects on the lean production system, and on its socio subsystem in particular. These are used to formulate the **research questions** and the results I anticipate. A brief introduction to the **methodology** is included, as well.

Chapter 6 gives an account of the **survey** used for my analyses. Drawing upon previous research, a proposal is made for the **operationalization** of the technical and work organization practices of the lean system, operational performance indicators and manufacturing strategy goals. The characteristics of the sample used for the analyses are discussed, as well, along with other methodological issues.

The empirical analyses, the methodology applied and the discussion are contained in **Chapter** 7. Also, this is where, based on my findings pertaining to manufacturing strategy goals, I formulate the hypotheses and identify the limitations of my research.

The thesis is concluded with a summary (Chapter 8).

Figure 6. Chapters of the thesis and their primary foci

Chapter	Primary focus
1. The lean production system	Milestones in the development of the lean production system; defining the lean socio-technical subsystem
2. The theoretical model of the lean production system	Structure and practices of the lean socio-technical system – conceptual considerations
3. Focal points of the studies dealing with the socio subsystem of the lean production system	From amongst the focal points of these papers, emphasis is on the use and efficiency of HRM practices Presenting the impact of strategic goals, if any, with respect to the individual focal points
4. HPWS practices from the best practice and the synthesizing approach	Reviewing the operations management and HRM literature. Identifying any other factors affecting HPWS practices.
5. Research model, hyptheses, methods	
6. Presentation of the survey, and our variables, sample and methodology	Presenting the International Manufacturing Strategy Survey and operationalizing the variables
7. Analyses, discussion, limitations	
8. Summary	

The limitations of the study are numerous. It should be noted already at this early point that the study only **considers large manufacturing firms**. This may be justified by the fact that it is this group where the firms at the forefront of lean production come from. Lean management experience from other areas (smaller firms, service sector) will not be included. Our findings may nevertheless prove to be instructive for lean companies operating in other environments, and for modern quality management, as well.

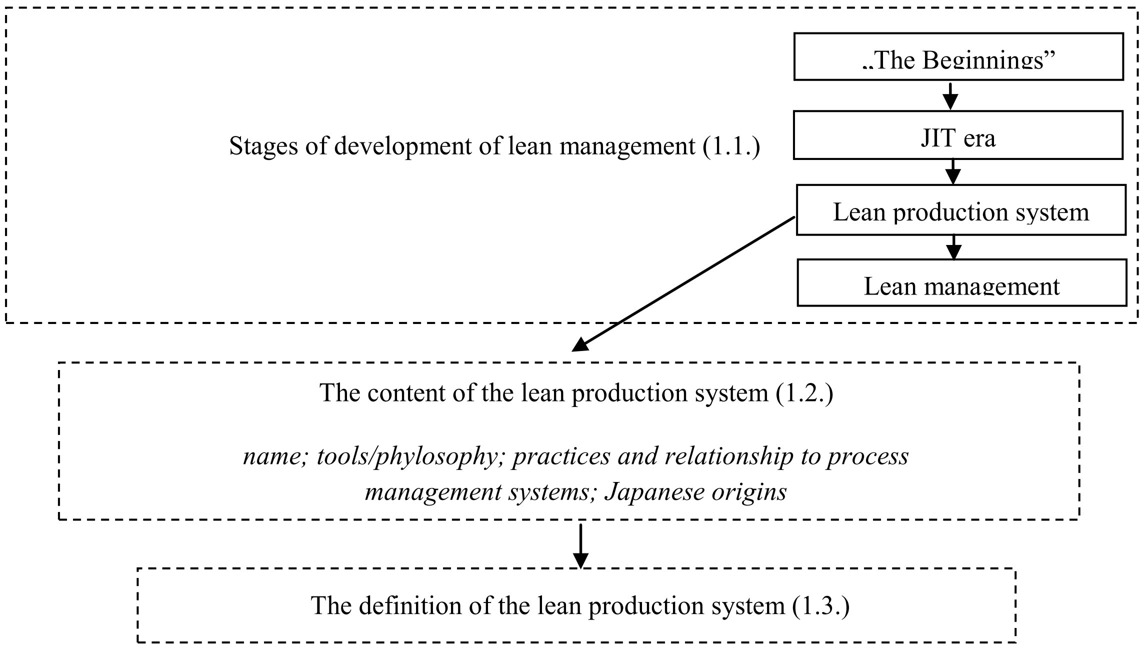
Another important limitation of the thesis is related to the literature review, which was dominated by works from the Operations Management field. No mention is made of the development and tasks of HRM. From the HRM literature, it is only the papers dealing with modern production systems and lean production that are included. Given that **my intention is to contribute to the science of Operations Management**, the conclusions pertaining to strategic goals are based primarily – but not exclusively – on this same literature base.

I would also like to highlight the difficulties of elaborating Research Questions 2 and 3. Sources that explore the impact that strategic goals have on HRM practices in any sort of production environment (let alone in a lean environment) are rather scarce. Though I strived to approach the issue to be researched from as many angles as possible (lean literature, Operations Management, HRM literature), several times I had to opt for an indirect way to arrive at my research questions (e.g. building upon contradictions in empirical findings or theoretical considerations). Any research effort aimed at the „strategic goals – soft factors – production" triad (or just the latter two, for instance lean production and organizational culture) will, in my opinion, have to face very similar impediments.

1. The Development and Definition of the Lean Production System

The chapter is comprised of three larger parts (Figure 1.1). Subchapter 1.1 provides an overview of the development that lean management has undergone during the last fifty years, and what its concepts stand for. Subchapter 1.2 deals with matters related to the content of lean production, and Subchapter 1.3 introduces the socio-technical approach to lean production. Chapter 1 relies on the part of the Operations Management literature that deals with lean management. Here, research into other functional areas and the management literature will be represented to a much smaller extent. The review involves the international as well as the Hungarian literature on the topic.

Figure 1.1. The structure of Chapter 1



1.1. The Main Stages of Development of Lean Management

It seems reasonable to begin with how the term *lean* came to life. The lean concept was introduced to the literature by Krafcik (1988). By now, lean has also become the term of preference in Hungarian, and it is the denomination that I am going to use throughout the dissertation, as well. In 1988 Krafcik published a study titled „*Triumph of the Lean Production System*” in Sloan Management Review. The author – along with Daniel T. Jones and John Paul MacDuffie, among others – was an active member of the International Motor Vehicle Program (IMVP). In the framework of the program, the researchers examined the components of automotive manufacturers' competitiveness. Krafcik **used the lean concept to describe the production system that the most outstanding vehicle manufacturers employed**. In its original form, the concept did not only refer to Japanese manufacturers, let alone exclusively Toyota.

The appearance of the lean concept in 1988 was not without history, however. The core of lean management as well as Toyota's management system had already been well-known (Monden 1983; Sugimori et al. 1977; Ohno 1988) and present in firms' practices (Holweg 2007; Schonberger 2007). The management system was first introduced to the Hungarian literature in the end of the 1980s by an application guide edited by Dr. Ernőné Makra titled „*JIT vezetési perspektíva*” (approx. „A JIT Management Perspective”) (Makra 1988).

Lean management evolved, in my opinion, along the following milestones:

- **„The Beginnings”**: Toyota's production system was, according to Fujimoto (cited in Holweg 2007), the result of „crossbreeding”: they adapted various elements of Ford's system and enhanced them by incorporating Toyota's own solutions and experiences from other industries. Modern quality management had an important role, as well. The principles and tools were only known within Toyota's own network and in the circle of Japanese firms.
- **JIT era**: Toyota's practice became widely known in the West during the 1970s and '80s under the name JIT. As the term suggests, attention was then focused on the process organization techniques closely linked to production, which were taken out of their then already known organizational context (i.e. tool set and management system). Even though the studies of the time **stressed the comprehensive nature of JIT, focus soon shifted to understanding the technical tools and the results.**[7]

[7] Technical dimensions became dominant in research, and therefore little is known about how firms interpreted JIT in that period. Did they regard it merely as a technical system indeed? Chances are that changes in (the development of?) the literature mirror the changes in researchers' perspective (interest, curiosity, priorities).

JIT as a production organization principle was also discussed – mainly by contrasting it with the logic of the material requirement planning system – in the Hungarian literature; see Nagy (1991). Several (teams of) experts dealt with the topic around that time, yet it did not become widely known in the industrial sector of Hungary.

- **Lean production system**: by the mid-1990s, interest in lean transformations had become intense internationally. The period differed from the JIT era of the 1980s under two important aspects: the previously prevailing approach of adapting just a couple of practices was replaced by comprehensive, **„program-wise" adaptation;** and **lean production came to be applied by a much wider circle of firms**[8]. The lean production system transformed firms' operation through strategic (Vörös 2010) and functional connections, and formalized frameworks. Work organization was a topic of discussion, as well, as part of the organizational framework. It should be noted, nevertheless, that what complex lean transformations often did was to simply „re-label" the joint use of JIT, TQM, AMT (*Advanced Manufacturing Technology*) and TPM (*Total Productive Maintenance*).

  The lean system, as one to foster firms' competitive capabilities (Kelemen 2009; Koltai 2009; Vörösmarty 1999), had become the dominant strategy in production system organization by the mid-1990s (Havas 1996; Karlsson and Åhlström 1996), some authors even refer to it as the most influential paradigm[9] in the field (Hines, Holweg, and Rich 2004). As Kovács (2004, p. 63) put it: „*A multitude of businesses used Toyota's production system as an example to build their own, whether they admit it or not.*"

- **Lean management**: in line with the best practice approach, this period is characterized by the gaining ground of lean principles (irrespective of organization, context, strategy or industry). Two facets of the changes are of particular importance:

  (1) From the manufacturing activities of mass producers, the lean system had started to trickle down to processes of a complexity different from that of mass production,

[8] I did not manage to find any research findings that would support these two statement. Some latent thoughts present in the literature do, however, suggest these two explanations, in my interpretation. Especially given that they are also encountered in papers dealing with the extent of use of HPWS practices (see Chapter 4).

[9] At an earlier point in the thesis, the term paradigm meant the research paradigm, i.e. a coherent system of assumptions pertaining to the research. As already indicated there, paradigm stands for something else when used in connection with lean production: it signals the lean system's being radically different from the traditional system.

e.g. in the organization of services (Kovács and Uden 2010), the knowledge industry (Staats, Brunner, and Upton 2011), office tasks (Jenei, Losonci, and Demeter 2007; Németh 2009; Swank 2003), logistics (Gelei and Nagy 2010; Reichhart and Holweg 2007), the public sector (Radnor et al. 2006) and health care (Jenei 2010a; Jenei 2011; Spear 2005; Tóth, Seres, and Fábián 2010). From the late 2000s on, this „opening up" of the lean system has been particularly conspicuous.

(2) The relationship between the lean system and its organizational context, i.e. between production and the remaining organizational functions, has gained in significance, for instance it is not only the production processes that need to be reconsidered, but the organization's culture needs to be transformed, as well. Another indication of the importance of organizational context is the frequent use of the expression 'lean philosophy' (Liker 2003; Liker and Hoseus 2008; Rózsa 2002; Topár 2009). Hungarian authors, as well, underline the role of organizational culture, for instance (Andriska 2004; Marosán 2003; Toarniczky et al. 2012). This interest in organizational context and in issues related to the human factor makes for a favorable atmosphere for studies employing the socio-technical approach.

The main stages of development of lean management are summarized in Figure 1.2.

Figure 1.2. Changes in the content of lean management

Stage	Period	Most important contentual aspect
„The Beginnings"	**from 1940**	Evolution of the Toyota Production System Spread of modern quality management, Japanese (Toyota) innovations
JIT era	**1970-1980**	Toyota's production system is a complex management system, yet firms' practice puts the emphasis on developing the material flow (e.g. JIT) and implementing certain tools.
Appearance of the lean concept	**1988 and 1990**	Krafcik (1988): lean designates the global top-performers of the automotive industry Womack et al. (1990): the lean concept acquires international fame; its best practical implementation is Toyota's production system
Lean production	**from the 1990s**	Lean production is the prominent production paradigm Appearance of program-like lean production systems, synergies between tools, organizational environment
Lean management	**from the late 1990s, prominent from the mid 2000s**	Areas other than mass production, e.g. services, customized processes Lean philosophy: lean company, that is, the organizational environment and all the other organizational functions comply with lean's principles, as well

The stages were delimited according to whether a new and dominant priority had appeared in lean management. In Figure 1.2 we see the outlines of an organic development process. **Each stage made use of the preceding stages' results**: they reinforced the preceding stage by **contemplating its problems**. That is, following the appearance of the lean concept, the „lean production system" stage strived to figure out how a set of tools could be turned into a system to support business goals. The „lean management" stage already looks beyond production and urges to reform the entire (extended) firm. The last two stages coincide in their interpretation of the lean tools and emphasis on the strategic perspective.

My research relies on works published during the 1990s and 2000s, during which period the substance of lean production remained, to all intents and purposes, unchanged. Notwithstanding lean management's recent appearance in areas other than production, it is still at large manufacturing firms that it is present in its most comprehensive form. This is also the circle of businesses that – in accordance with the relevant international trends – my research intends to survey.

1.2. Approaches To and the Content of the Lean Production System

Subchapter 1.1 paints a uniform picture of the lean production system, whereas in fact the historical dimension of the picture is not quite that uniform. There have been changes, especially during the 1990s, that gave rise to substantial, still-prevailing contradictions. The present subchapter sheds light on three such topics: name, content and Japanese origins. The discussion of these three items will unmistakably clarify the lean production concept as it is used in the present thesis, and thus justify the logic I relied on in selecting the literature to be reviewed (concerning both the keywords and the time horizon).

Name. In the course of the last 20-30(-50) years, lean management has been referred to in professional circles by the terms JIT, Toyota Production System and lean management, sometimes even interchangeably (Schonberger 2007; Shah and Ward 2007).[10] Whereas at Toyota, TPS denoted the complex (production) management system, JIT meant the implementation of the pull system in materials management (Ohno 1988; Sugimori et al. 1977; Toyota's website)[11]. Despite the differences, **the „Western" JIT system of the 1970s and '80s was – especially if employed together with TQM and TPM – a close relative to TPS. According to our present interpretation, both largely correspond to lean management.** My thesis embraces the same approach. This statement will have a particularly important bearing on the identification of the body of literature to be reviewed.

The fact that the name of the lean system has repeatedly changed in the past raises a number of questions concerning the future. Apparently, a name change is due every 10-15 years. The previous tendencies suggest that the appearance of a new name may well be imminent. Attempts have, in fact, already been made, e.g. lean six sigma. We also know that the reason behind each previous name change was the re-evaluation of some false assumption about the underlying relationships (e.g. switch from JIT to lean production; transition from lean production to lean management). The future new name will probably reveal which of our current assumptions about lean management are false.

[10] Another way of resolving the confusion about the name might be to coin a new one: Harrison and Storey (1996) refer to innovations in the production field collectively as „*new wave manufacturing*". I believe however that it is useful to be clear about how the terminology has evolved. A less ambiguous historical picture may actually render the findings of past studies utilizable.

[11] Toyota Production Sytem (2014)

Content of lean management – tool set, philosophy, relation to other process management systems. The variation in nomenclature foreshadows certain disputes over the content. Everyday industrial practice provides numerous examples for the uncertainties that the difficulty of defining lean management's content give rise to. That is how it can happen that (process) development programs of just any sort are treated as lean-driven, whereas some of the reforms treated as non-lean may well be in perfect harmony with the lean system.

There is no consensus among the academics researching the content of lean management about the practices of lean production, and they are divided over the 'tool set' and 'philosophy' approaches to the lean system, as well. Shah and Ward (2007) suggest that opinions center about two viewpoints:

(1) the practical perspective focusing on the set of directly observable management practices, tools and techniques (e.g. Li 2000; Shah and Ward 2003), which I also refer to in the thesis as the **tool set approach**; and

(2) the **philosophy perspective** concerned with principles and comprehensive goals (Spear and Bowen 1999; Womack and Jones 2003; 2009).

One representative of the tool set perspective is Schonberger (2007), who suggests that **deep down, all the global best practices have Japanese roots**. He mentions concepts like cost of quality, design for manufacturing and assembly, rotation/skill-based pay, direct and activity based costing, total quality management and teamwork, public recognition, reorganization, continuous replenishment and supplier-managed inventory, lean production, six sigma and collaborative supply chain management. The author stresses the implementation of the tools.

Hines et al. (2004) **identify the strategic/philosophical level of lean management with the five principles of general lean thinking** (Womack and Jones 2003). To them lean production is the whole that encompasses all the parts, and not just a central element as for Schonberger. They believe that it is manufacturing best practices (e.g. JIT, kanban, six sigma, TQM) that translate the lean principles into everyday practice. According to the philosophy approach, the strategic side and the practical tool set of lean management continuously integrate the practices of

Operations Management (and those of more general management areas and other functions, as well).

As I see it, the **lean tool set vs. lean philosophy „debate" in Operations Management is currently dominated by the latter viewpoint**. This perspective, as well, attaches great significance to the tools, it is just that they ought to be part of a management system/way of thinking and, hence, subordinated to its goals. The philosophy perspective can be associated with the stream that urges the program-wise implementation of lean management.

If we **regard the lean system as an integrated production system (i.e. a broad set of tools), then there is no discernible difference between the 'tool set' and the 'philosophy' perspective** – at least as far as the operationalization of practices is concerned. Empirical findings confirm, too, that the long-term presence of a large number of lean tools indicates the prevalence of the lean philosophy in the organization (de Menezes, Wood, and Gelade 2010). The difference between the two perspectives only becomes apparent if the focus is limited: lean implementations limited to a few practices only (rapid improvements) are considered lean by the tool set perspective, whereas the philosophy viewpoint does not regard them as lean management. In such cases, the goals/principles/tools that would drive the firm towards a complete lean transformation are missing.

My research takes the strategic/philosophic perspective. In addition to the technical practices that originate from Japan, lean production also incorporates the popular schemes (e.g. TQM, BPR, TPM, JIT, six sigma) and work organization practices of the recent past.

The origin of the practices, Japanese roots, the embeddedness of the practices. The cultural, political and institutional embeddedness of the Japanese management system has been extensively researched both internationally (Special Issue of Journal of Management Studies, Vol. 32, No. 6) and in Hungary. These factors may well have had a significant impact on the evolution of the Japanese management system, but their investigation nevertheless falls outside the scope of Operations Management.

By the 1990s, certain areas of the Japanese management system – among them its production scheme – have established themselves as best practices: *„…the new paradigm of production and work organization does travel everywhere with the Japanese”* (Morris and Wilkinson 1995, p. 728). In the early 1990s, research into manufacturing best practices still showed interest in Japanese companies. Yet this interest was not directed at understanding the cultural effects but to use the Japanese as a basis for comparison (with respect to operational performance, and the use of technical and HRM practices). As a result of the best practice approach to lean production, the Operations Management literature does not even truly aspire to distinguish between practices by national origin, and understanding the impact that embeddedness had on the evolution of any given practice is not in the forefront of attention, either.

Globalization (production networks, outsourcing, subsidiaries, emerging markets) has led to cultural and geographical considerations, and the various aspects of internationality receiving more and more attention in Operations Management, as well. Moyano-Fuentes and Sacristan-Díaz (2012) highlight the potential effects of geographical context, economic status quo and socio-economic structures specifically in connection with the lean system. However the studies they reviewed had also been limited to examining the firms of a single country or comparing the companies of just a few nations (regions). Whereas the findings on national values, national cultures and economic and social structures might well enable us to get a clearer picture of the global application (applicability) of the lean system.

In summary, it can be concluded that throughout its evolution lean management has heavily drawn upon the practice of Japanese companies, and Toyota in particular. Still, the appearance of the term ’lean’ constitutes an important milestone not only in the system’s nomenclature, but in its content and in the extent of its application, as well. Its broad set of tools covers the earlier concepts (JIT, TQM, TPM, AMT) and also extends to work organization. At the same time it is also obvious that sustainable success demands more than just the isolated implementation of the tools. The lean system can only be successful if the realization of the principles is supported by the program-wise adaptation of the tools, and if reforms are not limited to production only, but all the other functions and the market relations (customer and supplier) must likewise be rethought. It is this spirit that the socio-technical approach and the definition presented in the next subchapter reflect.

1.3. Definition of the Lean Production system

The Operations Management literature is not in agreement about either the definition of lean production or its practices. My thesis relies on Shah and Ward's (2007) definition of lean production:

„Lean production is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability" (Shah and Ward 2007, p. 791). Their findings evince that the lean system is dominated by technical (management of external (customer and supplier) context and internal processes) elements[12]. The emphasis on the socio-technical approach notwithstanding, their socio subsystem „only" includes employee involvement, which covers participation in problem solving and cross-training.[13] As regards the definition, my dissertation embraces Shah and Ward's (2007) proposal, yet in identifying the socio practices of the lean production system, I draw upon other works, as well (e.g. MacDuffie, 1995; McLachlin 1997; Lewis 2000).

Though definitely arbitrary, this choice of definition is justified by several factors: (1) Shah and Ward's research was not limited to merely defining the concept, but they also investigated the practices of the lean production system by empirical analyses; (2) it was based on the review of an extensive body of literature, with due attention to other production systems (Toyota Production System, JIT and TQM); (3) the definition underlines the socio-technical nature of lean production; (4) still today it qualifies as the most comprehensive study on the topic.

A key concept in the definition is variability. The lean system attaches importance to offering flexibility and variety to the customers, thus it is not the elimination of these that the reduction of variability refers to. The aspiration to eliminate variability

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[12] Suppliers: supplier feedback, JIT supply chain, supplier development; Customers: customer involvement; Internal processes: pull system, flow, quick changeover, controlled processes, preventive maintenance, employee involvement.

[13] This bias may be partially explained by operations management's focus of interest. Researchers tend to rely on previous research in identifying variables – which in this case was dominated by technical attributes. That is, if a given practice has not appeared as part of the lean production system before, then chances are it will not be able to make it into future studies, either.

is connected with standards-based operation. Operating according to pre-defined standards is an imperative in the lean system. Any deviation from the standard requires intervention. It is the very existence of the standard that allows for the deviation to be recognized; and if there is a deviation, its causes must be identified and countermeasures implemented. Even the processes of identification and correction are performed according to standards. The elimination of variability refers to the standardization of processes/activities. The elimination of variability appears in another context, as well, as it is a precondition to the third lean principle (third principle, see Womack and Jones, 1996). The third lean principle is about the elimination of wastes related to the variability of demand (unevenness=mura, overburden=muri), for the lean system is incapable of handling demand fluctuations.

Chapter 1 has provided a general overview of the lean production system and proposed a definition that is socio-technical in character. Chapter 2 will direct our attention at the key role that work organization practices hold in the lean production system.

2. The Theoretical Model of the Lean Production System – Its Structure and Practices

Chapter 2 comprises three parts. The first one (2.1) introduces the operating models of the traditional and the lean organization. Subchapter 2.2 outlines, based on the mainstream Operations Management literature, the structure of the lean production system, and the relationship between socio and technical practices. The third part of the chapter (2.3.) discusses the logic of the connection between the socio and the technical subsystems.

2.1. The Traditional and the Lean Organization – General Operating Models

Aoki (1990) compares the main attributes of traditional (H-mode) and Japanese (J-mode) organizations. His 'Japanese organization' may be equated with the lean organization (Taira, 1996).

According to Aoki the operation of the two organizations differs in the mode of intra-organizational coordination and under two further aspects (Figure 2.1). He associates vertical coordination with the traditional organization, and horizontal coordination with the Japanese firm. In the H-mode, the hierarchy acts to separate design from implementation, and economies of specialization have an important role. Such an organization has "built-in" measures (e.g. inventories, troubleshooting specialist) in place to deal with unexpected events. Even in the best case scenario, new information/knowledge can only be utilized in the next planning phase. The J-mode relies on horizontal coordination and the sharing of on-site information. It is able to flexibly handle new information and adjust the plans accordingly. This type of coordination can only be efficient if the organization gives up specialization, and concentrates on communication and development (people development, too) instead.

These characteristics have numerous implications for everyday operation. Aoki points out, for example, that the two logics of operation differ in the way they manage people and the workforce. Horizontal coordination and common learning

„*rely*[.] *on highly qualified and diligent blue-collar workers who have formed the core of the work team*" (p. 9). To communication skills, the ability to work together with peers, problem solving skills, the knowledge of the process, rotation and the incentive system that supports all these, he refers to as the pillars of work organization.

Drawing from Aoki we may conclude that horizontal coordination and information/knowledge sharing are two such characteristics of the lean organization that increase the value of the worker and work organization. If applied to the Operations Management literature, this train of thought implies that in the altered organizational model, the socio and the technical subsystems need to be dealt with together.

Figure 2.1. The traditional vs. the Japanese (lean) organization

H-mode (traditional)		**J-mode (Japanese, lean)**
vertical	*mode of coordination*	horizontal
- hierarchical separation between planning and implemental operation	*first main feature*	- horizontal coordination between operating units
- economies of specialization	*second main feature*	- sharing of ex post on-site information
1. prior planning by **specialized top-level units**	*Consequences*	1. prior planning only provides an indicative framework for implementation
2. prior plans **frozen**		2. **prior plans may be modified if new information emerges in the course of implementation**
3. **lower levels accountable for implementation**		3. the realization of organizational goals demands **inter-unit coordination**
4. **a priori devices to cope with random events** (buffer inventories, specialists)		4. **economies of specialization sacrificed**, time used for acquiring information, and communicating and bargaining with each other for coordination
5. **generated knowledge used by the higher office for the next round of planning**		5. **hardware, software and people need to be developed**

Source: author's own compilation based on Aoki (1990)

2.2. The Structure of the Lean Production System

According to the socio-technical approach, a production system consists of a technical and a socio subsystem, which in turn are comprised of practices. It is the content of the individual practices and the relationship between the two subsystems' practices that determines the type of the given production system. The lean system, the traditional (Taylorian/Fordist) mass production system[14] and agile production (Gunasekaran, 1998; Gunasekaran et al, 2002; Sharifi are Zhang, 2001) are each a type of production system. The thesis deals with the lean production system, using the traditional mass production model as a point of reference.

The first step in describing the lean production system is to identify the practices that make up the two subsystems. As already mentioned in the Introduction, both the technical and the socio subsystem of lean production are related to best practices.

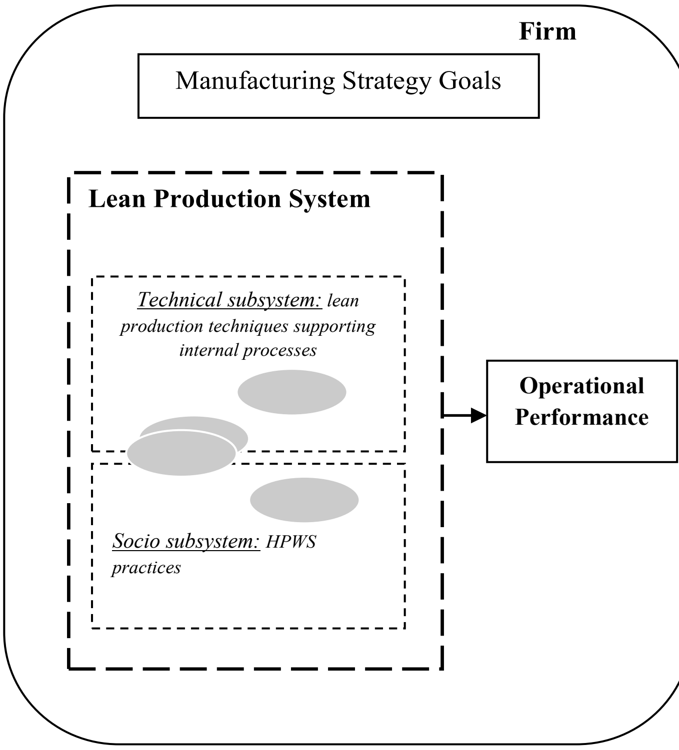
Concerning the technical subsystem, one needs to decide whether it is to only include the tools that pertain to production in its narrow sense or the tools employed in other areas of the value-creation process, as well. I will, based on what has been said in Chapter 1, adopt the latter approach, i.e. consider the practices related to both the input and the output side to be part of the technical subsystem. In this regard, firms' lean „maturity", too, may be decisive. We may assume that it is the production tools that provide the foundation for managing the firm's external context. Compared to the theoretical considerations, Figure 2.2 contains a simplification: I will deliberately ignore those practices of the technical subsystem of the lean production system that extend beyond the boundaries of the firm. **Similarly, it will be the practices related to production/internal processes that the empirical part will focus on.**

The socio subsystem of the lean system – again according to the considerations detailed in the Introduction and Chapter 1 – involves HPWS practices (Figure 2.2).

[14] It ought to be the subject of an entire separate research project to explore what traditional production, traditional mass production and the Fordist or the Taylorian systems cover in operations management. Apart from clarifying the content of these concepts, their relationships with each other should be looked into, as well. Those concerned with the lean system usually regard them as synonyms and use them to mean the opposite of the lean system, and it is used in this sense throughout the thesis. As for now, I would just like to point out that the literature of lean production tends to make the impression that there is such a thing as a universal and uniform mass production system. Whereas in fact it might well be just as varied as the lean system. A more detailed discussion of these systems is however not needed here, as it is only their difference under certain fundamental aspects that has a bearing on the topic of the dissertation.

In this regard, the literature is less clear about how far the application of the different HRM practices is influenced by the firm's lean „maturity". Some suggest that certain work organization practices follow, with a certain delay, the implementation of production techniques, e.g. when the manufacturing strategy changes (Kinnie and Staughton 1991) or for TQM (Banker et al. 1996); to Sweden, HRM practices had arrived sooner than technical ones, see for example Dabhilkar and Ahlström (2013). The issue of chronology is not, however, part of the subject of this thesis. Others argue that in spite of the well-founded conceptual relationships between the technical and the socio elements, „human factors carry a relatively minor weight" (Taylor et al. 2013, p. 3) among the variables used to measure the lean system. I intend to resolve the problem of HRM practices' operationalization by performing a thorough analysis of the relevant empirical studies.

Figure 2.2. The lean production system – subsystems, practices, external and internal context



The practices of the lean production system form bundles, that is, they appear in internally consistent groups (e.g. MacDuffie 1995; Shah and Ward 2007). In Figure 2.2 the bundles are represented by the grey ellipses in the subsystems' boxes. The overlaps between these ellipses are meant to indicate that the practices are difficult to unambiguously categorize into one subsystem/bundle or the other.

The joint use of the practices (or bundles) yields synergies that improve performance. Performance can be interpreted along multiple dimensions (e.g. financial, operational, employee-related). The lean literature suggests that it is typically the indicators associated with Operations Management's classic sources of competitive advantage (cost, quality, timeliness, flexibility, reliability)[15] that improve. That is what the arrow joining operational performance and the lean production system in Figure 2.2 refers to.

Aside from certain significant simplifications, this is the schematic framework of the lean production system as outlined by the mainstream Operations Management literature. It is this framework that Subchapter 2.3 endeavors to fill: to explain why and how HPWS practices follow from the operational logic of the lean system.

2.3. Work Organization Practices of the Lean Production System – Organizational Logic

MacDuffie (1995) presents the socio-technical approach to lean production based on the *organizational logic* concept. According to the concept, **lean** (or in MacDuffie's wording: flexible) **production inevitably leads to the alteration of work organization practices.** I enhanced MacDuffie's concept drawing upon the work of Liker (Liker 2003; 2008; Liker and Hoseus 2008). The concept corresponds to the logic of Operations Management textbooks (Slack, Chambers, and Johnston 2010), is in line with the observations of Womack et al. (1990), is also present in MacDuffie's later work (MacDuffie and Kochan 1995), and it is a logical continuation and enhancement of Aoki's (1990) models. As I have already mentioned before: it is common practice in Operations Management to use traditional mass production as a point of reference for discussing the lean production system.

Because of the potential for disruptions (e.g. fluctuations in demand, machine downtime, supply issues) jeopardizing companies' economies of scale, traditional mass production operates with buffers. Buffers may take a number of different

[15] See Wheelwright (1984), or for a more recent approach: Demeter (2010). I will refrain from adding items other than strategic goals (e.g. growth, gaining market share etc.)

forms. One of them is inventory, but it might also manifest itself as waiting time or rejects. The reason why inventories are of particular importance is that they provide a „safety net". On the process level, that means that inventories separate the individual steps of the system from each other. That is, each step of the process operates independently of any problems that arise elsewhere in the system.

In the lean production system, buffers do not contribute to customer value creation, and are hence treated as losses (waste). Buffers (wastes) in the system are not only costly, but prone to conceal other problems, as well. High inventory levels conceal defective parts, for example, and thus hinder flexible adaptation. JIT aims at eliminating wastes.[16] In other words: JIT systems produce according to the customer's schedule and strive for a one-piece flow. The elimination of buffers instantly brings previously concealed problems (e.g. defective parts, inflexible responses) into the forefront. The impact of any problem is not limited to a single part of the system any more, as the elimination of buffers acts to link up the steps. Which means that any one problem affects the entire system.[17] The need to maintain the continuous operation of the system (prevent downtime, eliminate buffers) calls for the prompt resolution of problems.

Why the lean production system is said to have a different focus is that it relies on problem solving and flexibility instead of buffers, which also has significant implications for work organization. **In Toyota's system, problem solving – i.e. laying the foundations for a stable system – is the highest priority for production workers. Thus the key to problem solving in the lean production system are workers.**

As we have already mentioned, traditional mass production builds buffers to overcome disruptions. Due to the independence that accompanies buffers, the traditional system does not expect the worker to solve problems, to think. The worker

[16] Economic papers use the concept of buffer in a more general sense. Balaton and Chikán (1988) also list the workforce and capacity as a buffer, in addition to inventories. The present thesis applies the term in its narrow sense, i.e. to mean inventories. If we were to use the tripartite concept, we could say that the operation of the lean system relies on buffers other than inventories. The organizational logic concept shows us how lean builds upon the workforce instead of inventories, and how that transforms the way the organization operates. Regarding lean production, other authors also call attention to capacity buffers. „*Increased capacity is an inherent part of Toyota's production system*", which is explained by the close relationship between waiting time and capacity utilization (Vörös, 2010, p. 249).

[17] It is hardly a coincidence that in addition to lean, *fragile* was also considered as an option when naming the system (Krafcik 1988).

is a replaceable element of the system, performing a task very limited in scope (and highly specialized in nature). The high degree of specialization allows for short training times and continuous operation, even if fluctuation is high. Wages and strict supervision are used to keep performance at the desirable level.

In flexible production, the key element is the worker. It is **through learning and the development of workers' skills**, as opposed to building buffers, that the system prepares for variability. The worker is only able to contribute to the **detection and resolution of problems** if they are **familiar with the process and capable of analyzing the problem/process, as well**. It is the **decentralization of responsibilities** (i.e. not leaving **quality control, maintenance, job specifications and statistical process control** to specialists exclusively) that provides the opportunity for workers to directly encounter problems. Employee problem solving requires their **training** to be extended: cross-training of workers; on-the-job training; off-the-job training; fewer but broader job specifications; rotation; group problem solving.

Such a system can align production with customer demand: is the demand high, there are more workers, is it lower, then there are less workers or just one worker (or none at all) working on the given line. A condition is that **all members of the group should strive to become familiar with all the work phases**. Workers' motivation and compliance with Toyota's principles (culture) is also influenced through **recruitment** and the **motivation (reward) system** (Figure 2.3).

The utilization of workers' knowledge presupposes the harmonization of individual and corporate goals. In exchange for the extra effort expected of them, workers expect more of the company, as well **(reciprocity)**. Therefore the following are also considered to be characteristics of the high performance work system: **security of employment**; **compensation** that is partially **contingent on performance**; **reduction of status barriers between workers and managers**. Employee training is another manifestation of reciprocity.

Figure 2.3. The organizational logic of the lean production system

Process organization side

Contribution to human resource management

Flexible operation while ensuring continuity → Elimination of buffers (JIT and one-piece-flow) → Immediate solving of problems prioritized → **In the focus: the worker** →

- Learning and skills development: identification and resolution of quality problems, knowledge of process steps (rotation), extended tasks
- Decentralization of responsibilities
- Recruitment and motivation
- Reciprocity – security of employment, motivation scheme, equality

Source: based on MacDuffie (1995) and Liker (2003)

There is one more thing to be added to the above train of thought, which is frequently left out of consideration and thus has given rise to many a misunderstanding. One of the key elements of Toyota's system is "all-inclusive" standardization (Spear and Bowen 1999). Standardization requires a very disciplined organization and the extensive monitoring of the employees. Paradoxically, it is standardization that makes employee involvement (and continuous improvement, too) possible. The involvement of employees occurs in a highly regulated fashion. The workers have the task of fine-tuning the standards (eliminating variability in the execution of work processes and creating new standards).

According to the organizational logic concept, **the lean reorganization of production processes necessarily involves the joint implementation of lean production techniques and high performance work organization practices.** The concept is – though demonstrated by the example of a mass production environment – a universal operating model.

3. Human Resource Management Practices of the Lean Production System

This chapter will commence by introducing the process of selecting the pieces of literature that Chapters 3 and 4 rely on.

The multidisciplinary nature of the research problem necessitated the review of the literature of both Operations Management and HRM. When „combining" two branches of science, one is immediately faced with the problem that, with respect to business performance, each discipline tends to investigate the effects of its „own" practices. Lean's technical elements we encounter, for the most part, in the Operations Management literature, and HPWS practices in the HRM literature. Researchers of one field will usually confirm that their „own" practices do – positively – affect performance. The potential effects of another discipline's practices are rarely analyzed. Which rarity is particularly conspicuous in view of the tendency to frequently underline their significance, as is the case with HRM practices in the lean literature. Even the findings pertaining to the impact of each discipline's „own" practices might be hard to compare due to authors' differing interpretations of the concept of performance; in the literature of HPWS practices, for instance, financial, HRM and operational indicators are equally popular topics (Hesketh and Fleetwood 2006; Huselid 1995; Lengnick-Hall et al. 2009).

In my quest for (empirical) papers to be reviewed I was guided by the following criteria:

- they should contribute to our understanding of the work organization system of lean production, possibly even by focusing exclusively on HPWS practices (without ever mentioning lean);
- take a comprehensive approach to the socio subsystem of lean production (do not examine a single HPWS practice only);
- aid in clarifying the relationship between (manufacturing) strategy (goals) and lean production (and its individual subsystems);
- are based on questionnaire surveys of top management (for an overview see the attached spreadsheet (worksheet 'Details on the articles') and Table 6.2);

- draw conclusions pertaining to operational performance.

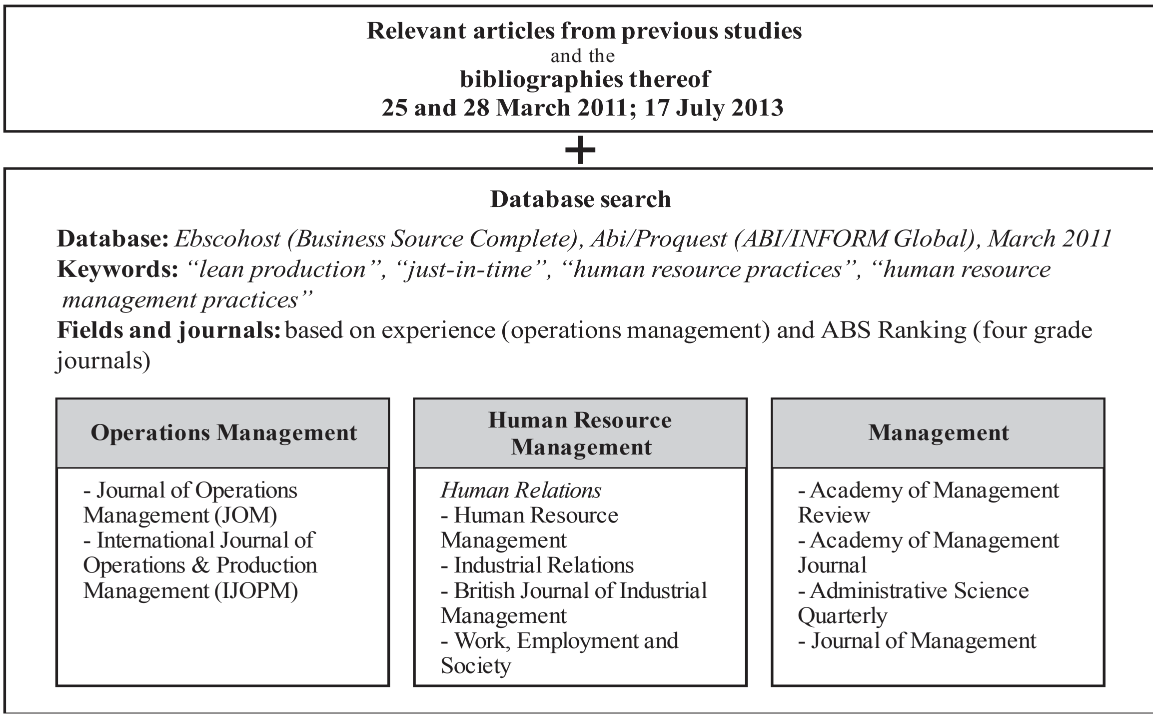
The papers I review in the dissertation are **comprehensive works dealing with the lean system or modern production systems (TQM, JIT and TPM, for example, appear as one integrated model)** (Cua, McKone, and Schroeder 2001; Flynn, Sakakibara, and Schroeder 1995). In consequence, pieces on AMT (Walton and Susman 1987) or TQM (Bayo-Moriones and Merino-Díaz de Cerio 2001; Bou and Beltrán 2005; Jiménez-Jiménez and Martínez-Costa 2009; Schonberger 1994), the latter of which has a socio subsystem similar to that of lean, are not included, and neither is the socio side of the more general process management concept (Ittner and Larcker 1997). The reason for this self-imposed limit is that the body of information associated with any one of the modern process management systems, let alone all of them combined, is vast. I would like to add though that the impact of strategic goals is a neglected topic also in the part of the TQM literature that I am familiar with.

A consequence of the **Operations Management perspective** is that the literature reviewed was almost exclusively of foreign origin. The majority of Hungarian studies on industrial work organization (Bódis 1997a; 1997b; 2002; Fazekas et al. 1983; Kemény 1990) take a sociological and/or economic approach, though some of them are closely related to the work organization innovations of the automotive industry (mass production). Héthy and Makó (1981), for example, discuss the major characteristics of mass production, *human relations* and the work organization practices of Volvo's Uddevalla plant. I have no knowledge of any empirical paper from Hungary that would be relevant to our topic and take an Operations Management perspective. Those works by Hungarian authors that regard HPWS practices as organizational innovations – yet do not expressly deal with production – were included in the review (see e.g. Losonci 2013).

The steps of the search performed under these „limitations" are shown in Figure 3.1. I relied on the papers that I had already been aware of as a starting point. Drawing from the bibliographies of these, I extended the list of relevant pieces of literature. I also performed a systematic search in various databases, primarily relying on that of EBSCO. The queries were run using the „*JIT/lean*" and „*human resource practices/human resource management practices*" keywords, and I limited the search to leading Operations Management, HRM and general management journals. I made my choices relying on my own experience and, in the case of the latter two disciplines, based on the rankings by ABS (Association of Business Schools, Academic Journal Quality Guide). The bibliographies of the articles so identified constituted a further extension to my list of potential sources.

The searches for my thesis proposal were performed on the 25th and 28th of March 2011. On 17 July 2013, preceding the empirical analyses, I repeated the search. The search process is discussed in detail in the document attached to the thesis. It was by reading the abstract/introduction/conclusions or the entire text that I decided whether and how a given article was relevant to my research.

Figure 3.1. The main pillars of my literature search



My literature review is not exhaustive (e.g. Organization Studies was not included in the systematic search), but the tendencies that characterize the Operations Management research perspective are outlined clearly enough. Based on the cross-references, I drew the conclusion that HRM-related findings had not really found their way into lean/Operations Management research.

Chapter 3 commences with a general overview of the international and Hungarian tendencies in lean management research (Subchapter 3.1.1). Next is the discussion of the relationship between lean production and human issues (Subchapter 3.1.2), followed by that of HRM practices (Subchapter 3.2).

3.1. Research on Lean Management

3.1.1. International and Hungarian Tendencies in Lean Management Research

Lean production is a relevant business practice: the number of lean transformations has multiplied during the last two decades (Bruun and Mefford 2004), and its practices are now in widespread use (see e.g. Anand et al. 2009). These tendencies are, however, less apparent in our immediate environment. It was a mere ten years ago that the majority (above 60 percent) of companies in the Central European region was found not to employ either lean production methods or a pull system or six sigma (Deloitte & Touche 2002). In international comparison, **the firms operating in Hungary** lag behind in the use of state-of-the-art production practices (Demeter 2007) in general, and **lag behind to an ever growing extent** with respect to the lean system in particular (Matyusz and Demeter 2010).

A clear sign of academic interest is the prominent position of lean management research in leading Operations Management periodicals[18] – as the abundance of both articles and references implies (Slack, Lewis, and Bates 2004; Pilkington and Fitzgerald 2006; Pilkington and Meredith 2009). An indication of „current" interest is the 2007 special issue of JOM or Harvard Business Review's edited collection of articles from 2008. **The topic was, nevertheless, even more common during the 1980s and '90s.** To me it seems as if lean as a topic had suffered a minute loss of popularity during the last one/two years in comparison to the five/six year period before that – though I have no data to support that. A sign of increased interest from the HRM field is the International Journal of Human Resource Management's plan to publish a lean special issue in 2013.

A remarkable phenomenon is that both conferences (e.g. the annual conferences of the European Operations Management Association (EurOMA)) and leading periodicals appear to be abandoning the production focus (Hasle et al 2012;

[18] JOM, IJOPM, Production and Operations Management (POM).

Dabhilkar and Ahlström 2013; LaGanga 2011; Staats, Brunner, and Upton 2011). Even „second-tier" academic journals reflect this same attitude (e.g. International Journal of Lean Six Sigma from 2010; International Journal of Lean Enterprise Research). It indicates a certain lack of sync between the practice and the academic field that academics' current interest lags behind the significance that practitioners attach to the lean system today (Slack, Lewis, and Bates 2004). On a by note, the situation may well have been the exact opposite during the 1980s and '90s.

In Hungary, both firms' practice and academic interest lag behind Western – and especially Anglo-Saxon – countries. Papers on lean management, empirical and theoretical likewise, are published in Hungarian peer-reviewed periodicals in rather limited numbers (Losonci, Demeter, and Jenei 2012; Kovács and Rendesi 2014). This "scarcity" is hardly, if at all, mitigated by also including articles written in English in the count (Demeter and Matyusz 2011; Losonci, Demeter, and Jenei 2011). Articles published in Hungarian journals and periodicals (like Magyar Minőség – approx. „Hungarian Quality", Minőség and Megbízhatóság – „Quality and Reliability", Logisztikai Híradó – „Logistics News", Supply Chain Monitor) have an important role in the domestic professional and academic dialogue, yet they are hardly more than an indication of interest.

There are, nonetheless, a number of factors that call for domestic research into the topic. The international actors of the industries pioneering lean production (e.g. automotive industry, electronics) have already established significant capacities in Hungary (Veresegyházi 2011) – and in the Central European region in general – and the Central European region may well succeed in attracting further investments (Szalavetz 2013). Its widening presence in lower levels of the supply chain, e.g. first- and second-tier suppliers, heralds the further spread of lean production on a regional level. The number of consulting firms, conferences and relevant websites may also be considered an „indicator" that suggests that more and more Hungarian firms are getting acquainted with lean management in one way or other. The contrast between the picture painted by the aforementioned studies (Hungarian companies' lagging behind in the use of the lean system) vs. the growing circle of potentially affected firms and the „buzz" observed in professional circles signals a curious contradiction. What we are witnessing is, most probably, that Hungarian firms are lagging behind in terms of organizational innovations, while at the very same time the „buzz" in professional circles is ahead of business practice. A commonplace remark still worthy of noting here is to point out the innovation gap between multinational corporations' subsidiaries and their supply chains vs. the domestic SME sector.

The socio-technical approach to the lean system and its empirical research is a novelty in the Hungarian literature, as well. Raising awareness of lean management as a socio-technical system is particularly topical, as it seems common knowledge in professional circles that in Hungary the lean system has been degraded – i.e. reduced to a mere cost reduction technique – as a result of the economic crisis (Jenei, Renczes, and Losonci 2012).

The domestic „lean scarcity" is somewhat mitigated by the fact that modern process management systems (e.g. TQM, six sigma, business process reengineering) have had a long history in Hungary. Our quality management periodicals function as a busy channel of idea exchange, and the field has its own national award and qualification system. As concerns the *empirical* investigation of these systems from an Operations Management perspective, the situation is quite similar to that of the lean system (Katona 2004; Németh 1998a; 1998b; 2000; Pataki 2000; Salamon 2011; Topár 2009; Tuczai 1997). In education, quality management gets more attention than the lean system (Csath 2005; Demeter et al. 2008; Kövesi and Topár 2006; Tenner and De Toro 1999). Experience from related events and conferences as well as from business practice indicates that lean management may join the Hungarian quality management scene (e.g. Magyar Minőség Konferencia, approx. „Hungarian Quality Conference") without further ado, without either of the two fields having to surrender their individual images.

The interest shown by the academic field and international business practice both confirm the topicality of lean management research. A circumstance that promotes the socio-technical approach is the shift away from the technical focus that had dominated lean research until recently.

3.1.2. Human Issues in Lean Management Research

It is a point of emphasis throughout the dissertation to point out that the key actor in the lean production system is the worker. Hines et al. (2004) go even further and suggest that **in lean management the key to a sustainable competitive capabilities**

is the human factor. The present chapter introduces several human factor related topics that are worthy of the lean literature's attention.

The motivation for the scrutiny of issues related to the human factor is that the problems and failures experienced during the implementation of the lean production system, and performance improvements' falling short of expectations are often directly related to the human factor. With respect to the potential failure of lean implementations, some authors direct our attention to infrastructural factors (e.g. strategy, quality management etc.) (Ahmad, Schroeder, and Sinha 2003; Anand et al. 2009) and workforce-related challenges. Research findings highlight resistance from the middle management, supervisors and workers (Emiliani and Stec 2005; LEI 2004), the problems associated with changing an organization's culture, lack of resources (e.g. for training), the lack of understanding and commitment from the management's side (Crawford, Blackstone Jr., and Cox 1988), and change management issues (Koenigsaecker 2005; Womack and Jones 2003).

A number of issues have already been thoroughly discussed in earlier papers. In the lean production system, the *role of line managers* (Lowe 1993) and the *tasks of the leadership* both change (Spear 2004), and *support from the management* gains in importance (Worley and Doolen 2006). *Work organization is transformed, as well*, e.g. *plant-level teamwork* (Delbridge, Lowe, and Oliver 2000; Tranfield and Smith 2002) and *cell production* (Hyer, Brown, and Zimmerman 1999; Fraser, Harris, and Luong 2007) gain ground, the *compensation scheme* (Karlsson and Åhlström 1995) gets redesigned, and *continuous improvement* (Aoki 2008; Farris et al. 2009) becomes important. Such an environment demands *other competencies* from the employees (whatever their position in the hierarchy).

Putting all these elements together yields the conclusion that we ourselves, as well, underlined in one of our earlier works (Losonci, Demeter, and Jenei 2010): **lean-driven transformations lead to changes in HRM similar in extent to those affecting production**. The result of the comprehensive organizational transformation that accompanies lean production is a **reformed structure** and **culture** (Smeds 1994). According to Liker (2003; 2008) lean production presumes a learning organizational culture.

The literature also deals with more general and widely debated topics, like the novelty of the lean system's work organization practices or the impact that lean has on the workers.

The **novelty of the lean/modern production system's work organization practice has been assessed by many, and the resulting evaluations span a broad spectrum** (e.g. radically novel (Castells 2005; Drucker 1990; Hines, Holweg, and Rich 2004), qualitative transformation (Adler 2007; Adler and Cole 1993; 1994), neo-Fordist (Makó and Nemes 2002; Takeuchi, Osono, and Shimizu 2008), post-Fordist (Dohse, Jürgens, and Malsch 1985; Graham 1993; Mehri 2006; Skorstad 1994)). This is a conceptual dilemma concerning which a large number of lean experts keep a rather significant yet unjustified distance from the Taylorian model (e.g. Hines, Holweg, and Rich, 2004). Whereas numerous lean advocates point out that Toyota's system was built upon the foundations of the Taylorian system.

The „competing" views are similarly diverse with regard to the other topic, the evaluation of the impact of the lean system on the workers, as well. The lean system is by many believed to be, on merely anecdotic grounds, a better production system (positive impact on the worker) than traditional production. The majority of those having examined the effects of the lean production system on the workers report the lack of the expected positive effects, or negative effects to be in excess of positive ones, e.g. unchanged employee satisfaction (Batt and Appelbaum 1995; Brown and Mitchell 1991; Jackson and Mullarkey 2000); increased stress, more health complaints and injuries, overburden (Landsbergis, Cahill, and Schnall 1999; Murphy and Sauter 2003; Sparham and Sung 2007; Berggren 1994; Brown and Mitchell 1991; Klein 1989; Mehri 2006; Parker 2003). Hasle et al. (2012) point out that as far as simple manual assembly tasks are concerned, lean affects both the work environment, and the workers' health and wellbeing negatively. Given that the most pivotal arguments of the criticisms directed at the lean production system concern its negative impact on the employees (Hines, Holweg, and Rich 2004; Treville and Antonakis 2006), the topic would surely deserve more attention and more large-sample surveys (e.g. Parker 2003). Sadly, in Hungary the issue is made all the more topical by the severe criticism that the working conditions observed at the Hungarian plants of some electronics manufacturers – which frequently employ lean techniques – provoked (Halaska, 2012; Perényi, Rácz and Schipper, 2012).

Until this point, I have presented the human issues of interest to us (spanning a fairly broad set of areas) from an Operations Management point of view. Yet it is not only Operations Management that is interested in the scrutiny of the relationship between lean production and human resource related matters. **Lean production, closely related to the Japanese management system, contributed to the laying of the foundations of several disciplines.** As the apt phrasing of Harvard Business Review's 2008 publication „Manufacturing Excellence at Toyota" also suggests, Toyota's success comprises more than just the reform of the production system: „*Few companies have so consistently inspired management best practices as Toyota.*" Miles and Snow (1984) for instance highlight that one of the reasons for the **increased significance of HRM** is the response to the Japanese challenge. It was not only the production practices, but those of numerous other functions, as well, that have made it from the management system of Japanese large enterprises (Marosi 1985; Móczár 1987; Whitehill 1991) into global best practices: „*the management literature has characterized many of the human resource practices found in large Japanese workplaces as best practice*" (Ouchi cited in Doeringer, Evans-Klock, and Terkla 1998, p. 171).[19] In addition to HRM practices, Japanese management also influenced **organizational culture** (Bokor 2000), while lean management left an impression on the literature of **organizational learning** (Dodgson 1993). Adler and Cole (1993; 1994) consider New United Manufacturing Inc. (NUMMI), the joint venture of Toyota and General Motors (GM), to be the archetype of organizational learning. Cooperation with these very fields of science may be particularly fruitful because the success of Japanese/lean companies had a key role in laying the foundations of these disciplines.

The human issues outlined above give a good indication of the organizational embeddedness of the lean production system. There is a great need for both the in-depth investigation of individual well-focused issues (e.g. compensation and benefits scheme) and the exploration of more general subjects (e.g. lean production and organizational culture/learning). The only way Operations Management and the lean

[19] The authors consistently use the „*high-performance, Japanese-style workplace practices*" expression. For now, I will not discuss the practices that his term covered; what is worth mentioning, however, is that from the set of practices then identified as part of the Japanese system, seniority has since disappeared and lifetime employment has „reduced" to security of employment by now. These changes can in themselves be interpreted as the adaptation of best practices.

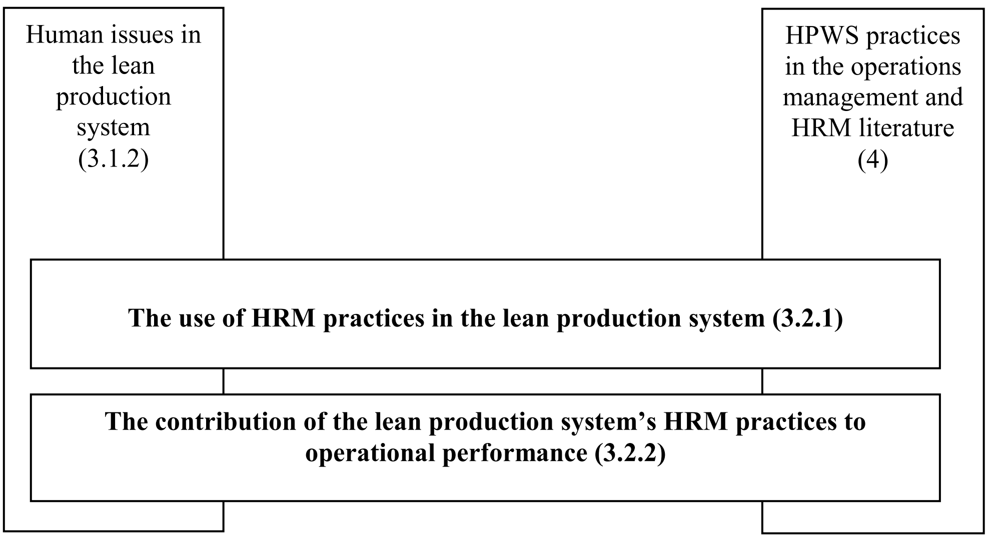
profession can benefit from such research efforts is by cooperating with the related disciplines.

3.2. The Human Resource Management Practices of the Lean Production System in Light of the Research Questions

Because of the radical effects of lean production, there are a multitude of facets of the lean/human relationship that deserve attention. From among the many possible influences, my thesis highlights a single small portion: work organization. The changes in work organization practices do, nonetheless, affect the areas that are not discussed here, e.g. practices that support involvement may facilitate the shaping of the culture, the adjustment of managerial and employee attitudes/roles/competencies.

Subchapter 3.2 deals with the **use of HRM practices** (3.2.1) **and HRM's contribution to operational performance (**3.2.2) in a lean production environment. Figure 3.2 illustrates that these two aspects are closely related to the soft side of the lean system, and to other disciplines, as well. The dissertation does, even if only in brief, also discuss these connections: positions its own narrow focus within lean HRM research (3.1.2) and points out a number of items that lean-interested professionals and academics may adopt from the HRM literature (Chapter 4).

Figure 3.2. The focal points of Chapter 3.2 and their relationship to other sections of the dissertation (chapter number)



The following chapters will leave the boundaries of the „closed" lean production system behind and put emphasis on the influence of strategic goals. The dissertation deals with two interpretations of strategic fit: one links the competitive capabilities set out in the business strategy to the practices of the various functions, while the other links manufacturing strategy goals (competitive priorities) to these practices. Whichever we mean, we know very little about the strategic fit of lean production. Batt (2007) concludes that the literature concentrates on the mutually complementary roles of the two subsystems, whereas the relationship between the two subsystems and strategy gets scant attention. Admittedly, the remaining influencing factors would deserve more attention, as well, yet as for this present research, they represent the limitations (like institution system (legislation, society, politics), unions, labor market situation, industry-specific characteristics, national culture (Jackson and Schuler 1995)).

The significance of the relationship between the lean system and strategic goals can be best captured by the **best fit and the synthesizing approaches**. The conceptual assumptions of these two approaches with respect to the lean production system are:

- given that HPWS practices are the practices of the socio subsystem of the lean system, and
- that strategic goals affect HPWS practices,

strategic goals may affect the lean system through the use and efficiency of HPWS practices.

3.2.1. The Use of Human Resource Management Practices

I will define the Human Resource Management practices of lean production based on conceptual considerations related to the organizational logic concept and on empirical findings.

Conceptual considerations. The work organization of Toyotism employs practices that support **employee involvement** and **flexibility**. With the elimination of first-line management, **certain managerial duties are delegated to the level of the**

workers (Drucker 1990; 2006). A condition for the smaller proportion of indirect employees and the „reshuffling” of responsibilities is that Toyotism goes against the further division of already narrow jobs, and **trains multi-functional professionals** instead (Castells 2005). These changes demand a standard-based mode of operation, that supports knowledge transfer (Adler and Cole 1993; 1994) and, for the sake of reciprocity, **employment stability**. Modern manufacturing organizations are furthermore permeated by further practices like **job expansion** and **rotation**, the jidoka system (the workers is authorized to stop the line), **teamwork** (e.g. quality circles), the appearance of temporary workers (Smith 1997). As for the direction of the changes, Makó et al. (Makó, Illéssy, and Csizmadia 2008, p. 1079) add that „*the literature also refers to lean organizations as high performance work systems*”.

Empirical findings. In empirical examinations of lean producers HRM practices, it is typically traditional mass producers that serve as a point of reference. The findings of the papers that take an Operations Management perspective do not concur; I managed to identify three streams:

1. **Relationship confirmed**. In many cases, findings are in line with the theoretical model of the lean production system (MacDuffie 1995; Oliver, Delbridge, and Lowe 1996; Power and Sohal 2000). Having analyzed an international database, we also concluded that lean producers tend to make more extensive use of HPWS practices (Losonci and Demeter 2010).

2. **Certain HPWS practices highlighted**. According to certain authors (Shah and Ward 2007), it is only a small set of HPWS practices in which lean producers outperform their non-lean counterparts. These HPWS practices are the ones associated with key elements of the lean production system like **problem solving** and **involvement**.

3. **Relationship ambiguous**. Others point out that corporate reality is much more colorful than the theoretical model. Lean producers often fail to surpass traditional producers even in HPWS practices that are closely related to lean production (Forza 1996; Oliver et al. 1994).

A common characteristic of the works that belong to the first stream is that they did not only compare the two extremes (non-lean vs. lean producers), but also account for the intermediate stage (create a certain transitional state between the groups of traditional and lean producers).[20] I believe that taking a more differentiated approach to manufacturing firms may prevent numerous inconsistencies. It is well possible that the degree of differentiation applied did have an impact on the findings that one or the other paper arrived at.

Papers of the second type only associate a couple of work organization practices with lean production (Birdi et al. 2008; de Menezes, Wood, and Gelade 2010). These HPWS practices are then considered to be key elements of the lean system. What raises a feeling of lack is that they fail to say anything about the HPWS practices that are present in the theoretical model of the lean system yet „missing” from their studies.

The argument for the lack of a relationship (type 3) is an interesting one: they state either that HPWS practices (Oliver et al. 1994) or that the technical practices of lean production (de Menezes, Wood, and Gelade 2010) are in widespread use. That is, they suggest that the very currency of the practices is what makes it impossible to detect a relationship between production and HRM. Even though HPWS practices are indeed widespread (Makó, Illéssy, and Csizmadia 2008; Valeyre et al. 2009a; 2009b), some studies suggest that this argument is not a very persuasive one (Makó and Nemes 2002). For, even though the new, lean-based production model is spreading dynamically,[21] the Fordist system has conserved its significance in today's knowledge-based society, as well.[22] In reality, however, it is a much more frequent occurrence that lean producers „forget about” the HRM practices.

As is always the case when writing a summary, the comparison of previous research findings presented me with serious difficulties in this case, as well. The researchers scrutinized different industries (or countries), and had rather diverse ideas about the technical and work organization practices of lean production. The Excel file attached to the thesis details the process of comparing the studies. The survey I rely on only allows for analyzing the application and the intensity of use of

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[20] A more differentiated approach to firms is also present in other areas of lean research (Ahmed, Tunc, and Montagno 1991). In my opinion, that was of benefit to them, as well, as it lead to less ambiguous results and more justified conclusions.

[21] The main characteristics of the system are a great degree of independence (decentralization) and working in a creative way.

[22] This international survey, conducted in cooperation with Hungarian authors, developed various models according to work organization practices, and it did not involve manufacturing firms only. Technical practices were ignored in the study. My research looks into the integration of the technical and socio subsystems.

the individual HPWS practices. It gives no indication at all of the practices' contents or workers' (and managers') views on them. The papers I reviewed were not any different in that respect, either.

Conceptual considerations seem to confirm that **HPWS practices** are – because of their embeddedness in the lean production system – **more frequently and more intensively used by lean producers than by traditional mass producers. Empirical works (questionnaire surveys) only partly support this relationship.** The ambiguity of empirical results certainly justify the investigation of the factors influencing the relationship between lean production and HPWS. The empirical surveys may be criticized for considering only a few of the HPWS practices appearing in the organizational logic of lean production.

3.2.2. The Use of Human Resource Management Practices – Relationship with Strategic Goals

Socio-technical empirical studies dealing with lean production rarely ever get to the point of analyzing strategic goals (i.e. testing the best fit / synthesizing approaches). Therefore it is the conclusions of

- empirical studies,
- conceptual considerations,
- findings about the relationship between the technical practices of lean production and manufacturing strategy, and
- empirical works that make references to the topic, but do not investigate it directly

that are presented in this section. Under each category, there is ample „evidence" for a relation between strategic goals and the lean system.

Empirical investigation of the best fit approach. In line with the best fit approach, Snell and Dean (1992) pointed out already in the early 1990's that business goals do not necessarily – not even in advanced manufacturing environments – justify the use of HPWS practices: „*…researchers still do not know whether increased investment in human capital or different approaches (e.g.,* *scientific management, defunctionalization) might lead to higher performance*" (Snell and Dean Jr. 1992, p. 496).

This is the thought that served as a starting point for Youndt et al.'s (1996) article, which was the only one out of the (lean-related) socio-technical literature I reviewed that focused on the impact of manufacturing strategy goals. **In accordance with the best fit approach, the study associates cost advantage with the *administrative*, and quality orientation with the *human-capital-enhancing* HR system**. Table 3.1 shows the HRM practices they assigned to each competitive strategy. It is apparent that the administrative system is in harmony with the traditional viewpoint, while the human-capital-enhancing system employs HPWS practices.

Table 3.1. The relationship between strategic goals and HRM practices

Strategic goal	***Cost-leadership***	***Differentiation (quality)***
HRM practices	*Administrative HR system* *Labor is basically a commodity* - Recruitment based on manual ability - Training includes policies and procedures (i.e. general information – and not the methods that facilitate outstanding performance) - Results-oriented performance evaluation, time work, individual incentives - Low qualification, manual work	*Human-capital-enhancing HR system* *Transition from manual work to knowledge work* - Recruitment - Recruitment based on professional (technical) and problem solving skills - Comprehensive training: including both professional (technical) and problem solving skills - Development and behavior-based performance evaluation system - Group incentives - Compensation – focused on the acquisition of skills and development

Source: based on Youndt et al. (1996)

The study considered manufacturing firms. Though it is not explicitly stated, competitive strategy can be assumed to determine, to a certain degree, manufacturing strategy goals. This is supported by the fact that they associate differentiation with TQM and quality management.[23] The researchers confirm **the relationship between**

[23] The authors do not only define quality orientation as a manufacturing strategy goal, but at the same time associate it with the modern production system (quality management, TQM). They exclude the use of TQM by companies that follow a cost-leadership strategy. Which, in my opinion, is one of the key issues of the best-fit literature: it is unwilling to „detach" modern production practices from quality-oriented strategic goals and the differentiation strategy. It does not even strive to link cost-leadership goals with advanced production systems, or to explain why they cannot be adapted by that circle of firms. One of the reasons might be that the classical best-fit works were written during the

the human-capital-enhancing HR system and a quality-oriented strategy. They also underline that even though it is the administrative HR system that would fit a cost-leadership strategy, that is not what these firms follow.

Conceptual considerations. The organizational logic concept describes the lean system as a „closed" system built upon best practices, where internal and external organizational factors have no role at all. The literature has, however, repeatedly put forward the suggestion that external and internal factor might have a significant influence on lean organizations, as well.

According to Aoki (1990) the traditional and the Japanese organizations are efficient in different environments. The H-mode may be more suitable in stable and extremely changeable environments. In a stable environment, it is not worth to sacrifice the economies of specialization, because the extra information and knowledge revealed at the operational level cannot be reasonably expected to substantially contribute to the design. The situation is similar in extremely volatile environments, where decentralized alignment may lead to uncertain results. It is **in an intermediate environment** that the J-mode, which can be equated with the **lean organization, can be effective:** when the **external environment is changing continuously, but not drastically**.

Figure 3.3. Traditional vs. lean organization – where do they function efficiently?

Traditional (H-mode)		**Lean (J-mode)**
Stable and extremely volatile environment	*Under which market conditions (variety, volatility) does it constitute a competitive advantage?*	**Intermediate environment**

Source: author's own compilation based on Aoki (1990)

Aoki suggested that by the '90s, most industries represented environments well-suited for the J-mode. As typical examples, he named mass production by complex

1990s. The contradiction would certainly be resolved if we assumed the cost-leader company to be contemplating a new competitive strategy (e.g. quality). Yet that would mean a strategy switch, which is not part of my research topic.

processes and the reduction of batch sizes (e.g. automotive industry).[24] As I will soon show, it is primarily through process choice – with the focus on technical practices, in particular – that the impact of the environment appears in the lean literature.

MacDuffie (1995), the creator of the organizational logic concept that my dissertation follows, did not take environmental attributes into account, either. MacDuffie is an advocate of the best practice approach and argues that it is because of the differences between mass manufacturers and lean producers that he does not concur with the best fit approach, e.g. with Arthur (1992).[25] There are significant differences between the works of MacDuffie and Arthur. Arthur (1992) distinguished between firms by strategic goals (cost-leader and differentiator), while MacDuffie classified the members of a relatively homogenous circle of firms according to their production practices (lean, non-lean and a transitional category in between the two). **MacDuffie limited his sample to mass-producing vehicle manufacturers**, and did not account for **luxury car makers**. MacDuffie **also limited the set of HRM practices**: he only considered HRM practices that could be applied in any one of the world's countries. He examined **the most homogenous production system possible**. MacDuffie's findings may also be explained as follows: mass-producing motor vehicle manufacturers are expected to deliver quality and be flexible. These expectations can be best met by organizations that – among others – make more extensive use of HPWS practices. That is, there is a pressure in the industry to adapt, and it is the J-mode, instead of the H-mode, that suits the altered environment. That is – in Legge's (2006) interpretation –, MacDuffie's **research confirms the best fit approach, as well:** it investigates the practice of firms that operate successfully in a changing environment. Legge (2006) believes the issues described above to be a general problem with papers dealing with HPWS practices. Surveys are limited to firms that operate in international markets, compete in quality and employ advanced technologies. In such an environment, it can certainly be proved that companies using no HPWS practices at all are lagging behind – for they have failed to adequately react to expectations.

[24] We must not forget that a central element of the J-mode is the well-trained and laborious blue-collar worker. Ensuring the continuous supply of such workforce is vital! By the '90s, the lack of blue-collar workforce had become a serious obstacle to growth, e.g. Aoki (1990) and Cusumano (1994).

[25] Arhur's work takes the best fit approach; the paper is discussed in detail in Chapter 4.

Sakakibara et al. (1997) call attention to the problems of interpreting the lean production system as a best practice. The authors assign differing lean systems to the different levels of Wheelwright and Hayes's (1985) four-stage model of manufacturing strategy. The stages of manufacturing strategy represent how production contributes to the organization's competitiveness. According to Sakakibara et al. manufacturers in the 3rd (*where production might actively support and strengthen the firm's competitive position*) and 4th (*where competitive strategy to a significant extent depends on manufacturing competencies*) stages can be said to employ JIT.[26] In Wheelwright and Hayes's (1985) view, the most remarkable difference between stages 3 and 4 is in the attitude towards human resources (Table 3.2). Stage 3 resembles the traditional model (*command and control*), while stage 4 is more like the HPWS model (teamwork, problem solving). Neither one of the two articles deals with HRM practices in detail. (Unfortunately, the original article's discussion of the differences in Human Resource Management across the various stages of manufacturing strategy is, too, confined to this same level of abstraction.)

Table 3.2. Alternative views on Human Resource Management in different manufacturing strategy stages

Stages 1, 2 and 3: traditional, static	Stage 4: broad potential, dynamic
„command and control"	learning
management of efforts	management of attention
coordinating information	problem-solving information
direct (supervisory) control	indirect (system and values) control
process stability/worker independence	process evolution/worker dependence

Source: Wheelwright and Hayes (1985, p. 104)

As it is apparent from Table 3.2, between the organizational logic concept of the lean production system (including its HPWS practices) and the 3rd stage of manufacturing strategy (traditional model, *command and control*), there is an irresolvable conflict: stage 3 proposes traditional work organization practices for JIT environments, as well. The socio subsystem described in the conceptual model of the lean production system is compatible only with the 4th stage of manufacturing

[26] This is a minor „deviation" from Wheelwright and Hayes's 1985 article on the stages of manufacturing strategy, which associates JIT and Japanese corporations with the 4th stage (Wheelwright and Hayes 1985).

development. **The explanation for the 3rd and 4th stages of manufacturing strategy both being associable with JIT is the best fit approach**.

The lean organization can be successful in a rather specific type of environment: a changing, but not drastically changing environment. The changing business environment (quality and flexibility gaining in importance), thus, acts in favor of the lean system, which underlines the significance of context. Moreover, there are examples in both theoretical and empirical works where, in accordance with the best fit approach, lean production is accompanied by traditional work organization. Based on the reasoning of Sakakibara et al. two models of the lean system can be distinguished: if our competitive advantage is to originate from production, then we can count on the HRM practices of organizational logic; otherwise, it is the traditional model of work organization that prevails, even in a lean environment.

The production process and the technical practices of the lean production system – relationship with strategic goals. Given that empirical papers applying the socio-technical approach are scarce, it surely would be instructive to review the effects that the choice of production process has on the lean system. The studies listed in Table 3.3 – based on Sousa and Voss (2008) – focus on technical elements, for the most part.

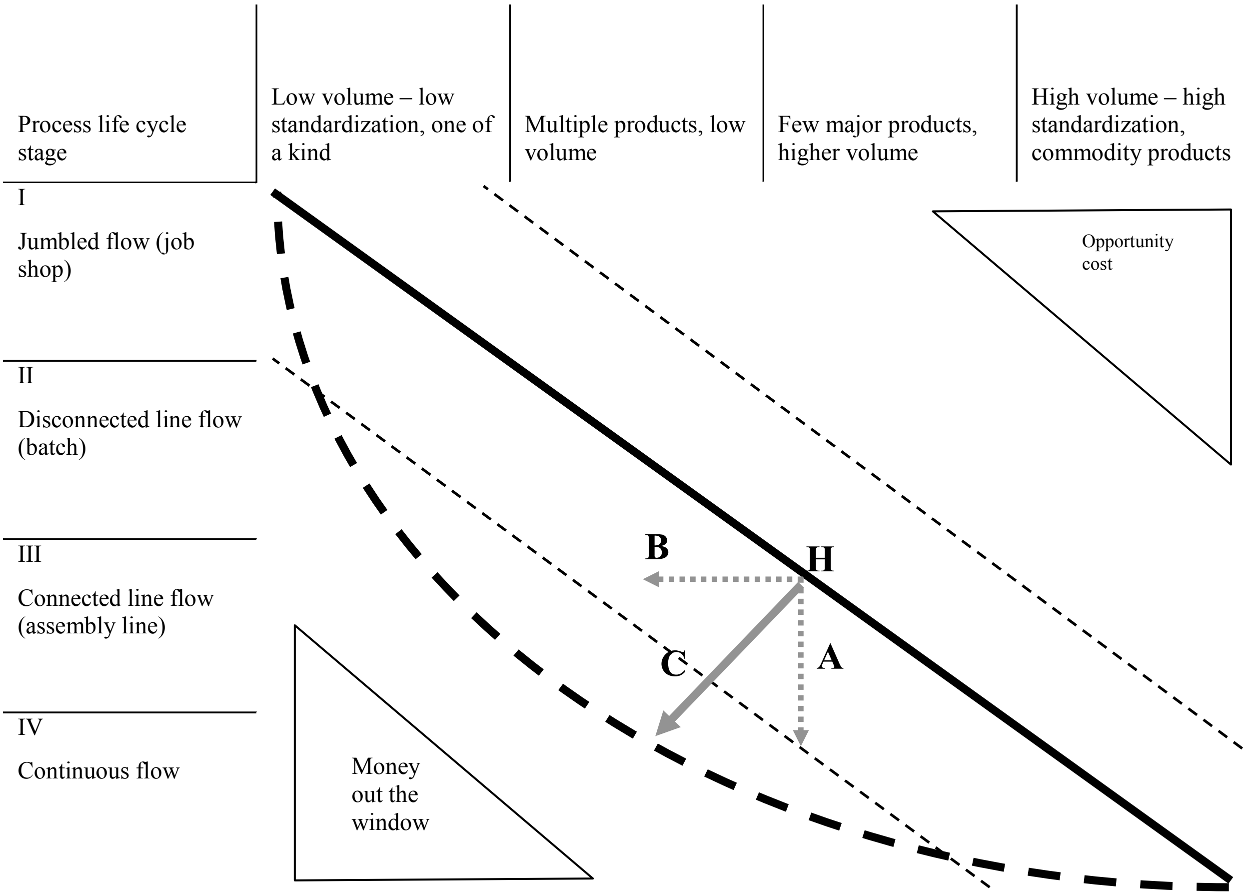
A common point of these studies is that production processes are classified into one of two extremes: job shop or mass production. According to the findings (questionnaires and case studies, but no large-sample studies here, either) **the production process does affect lean production: the lean system can be adopted anywhere, yet its use is to be expected to be broader in extent and more efficient with complex processes and in mass production environments**. Unfortunately, these studies do not deal with either manufacturing strategy goals or HRM practices.

Table 3.3. The impact of production process attributes on the lean production system

Author(s)	Research methodology	Factor examined	Lean production elements	Findings
Funk (1995)	theoretical	Logistical complexity: - number of production steps - number of parts handled	1. plant equipment (assembly lines, cells); 2. changeover time; 3. pull system; 4. inventory reduction and supplier involvement in the resolution of quality problems	- the importance (i.e. the results it may yield) and applicability of JIT (i.e. how many and which of its tools can be implemented) is proportionate to the logistical complexity of processes - also found a relationship between logistical complexity and the industry - JIT is useful in moderately complex (e.g. non-metal industry) and highly complex (e.g. high tech, metal processing) industries
Hobbs (1994)	case study	In a job shop, characterized by: - a wide variety of discrete product models and - varying batch size	1. quality processes (tidying up, organized workplaces); 2. visual control; 3. maintenance; 4. changeover time; 5. cell production; 6. flow; 7. kanban; 8. commitment to quality; 9. employee involvement	- JIT provides numerous advantages in job shop environments, as well, yet results lag behind those observed in repetitive environments
White (1993)	questionnaire survey (USA, N=1035)	production process (at least 70 percent of sales related to the given process): - job shop - batch - repetitive - process system	1. quality circles; 2. Total Quality Management; 3. focused factory; 4. Total Productive Maintenance; 5. changeover times; 6. group technology; 7. balanced workload; 8. multiskilled worker; 9. kanban; 10. JIT implementation	- JIT brings advantages under any type of production process - in comparison to other processes, repetitive production processes tend to use a larger number of JIT tools, with better results
James-Moore and Gibbsons (1997)	case study	- large volume or mass producer (automotive industry) - differentiated, small volume, rarely repeated products (civil space industry)	1. integrated one-piece flow, small batches, JIT inventory; 2. finding the causes of faults instead of correcting the faults; 3. pull (instead of push) production with balanced demand; 4. flexible, team-organized work, with multiskilled workers and few indirect employees; 5. active involvement in the identification of root causes; 6. close integration and partnership from the raw materials to the consumer; 7. significantly reduce overhead cost burden, flat organization, simplify information flow	- lean production is less typical in the space industry - differences in lean production are primarily due to dissimilar processes

If we acknowledge that process choice has an influence on the lean system, then the product-process matrix (Hayes and Wheelwright 1979) may be of assistance in identifying the effects on work organization (Figure 3.4). In the product-process matrix, which is based on trade-offs (Skinner 1969), programs that emphasize the interdependence of competitive capabilities can be represented, as well, e.g. lean (Hayes and Pisano 1994), JIT, TQM, CIM (computer integrated manufacturing), mass customization (Ariss and Zhang 2002; Kucner 2008; Safizadeh et al. 1996).

Figure 3.4. The lean production system in the product-process matrix



Source: Hayes and Wheelwright (1979), modified based on Kucner (2008) and Ariss and Zhang (2002)

In the matrix in Figure 3.4, the diagonal represents matching product and production process pairs (the diagonal denoted by the thick black line in Figure 3.4) (e.g. Demeter 2010). Flexible systems have shifted the trade-off point from its previous location on the diagonal to a new place. According to Ariss and Zhang (2002), the previous diagonal resembled a broad corridor (thin black dashed line). Kucner (2008) opined that lean firms expand the diagonal downwards, creating a parabola-like shape (thick black dashed line).[27] In Figure 3.4, firms' path from traditional mass production (point H in Figure 3.4) to lean production (C) can also be traced. The lean company can produce a more diverse range of products (towards B), while still preserving the advantages of „assembly line" production (towards A). The resultant effect is represented by point C: **large volume, wide product variety, production organized into a process**.

In addition to the process/product characteristics, work organization practices can also be assigned to the product-process matrix (Table 3.3). The upper left corner of the product-process matrix is characterized by **highly qualified workers**, general-purpose tools and a low degree of automatization. Proceeding downwards and to the right in the matrix, the degree of automatization increases, while **employees' level of qualification decreases**. In the last stage – i.e. continuous flow processes –, only a few, but extremely highly qualified workers are needed because of the advanced level of the technologies employed.[28]

Table 3.3. Organizational characteristics of the production process types from the product-process matrix

		Job shop			
Organizational attributes	**Project**	**Single-piece production**	**Batch production**	**Process system**	**Continuous flow process**
Type of organization	Entrepreneurial	Entrepreneurial	→	Bureaucratic	Bureaucratic
Level of qualif. req.	High	High	→	Low	High
Nature of qualif. req.	Technical	Technical	→	Manual	Technical

Source: Demeter (1999, p. 46) based on (Hill 1991)

In traditional mass production (point H in Figure 3.4), the „quest" for economies calls for Taylorian work organization (Table 3.3). The lean system pushes the

[27] Because of the shift of the diagonal caused by the appearance of flexible systems, a deviation from the original diagonal will not constitute money out the window / opportunity cost. What is more, if flexible systems appear in certain industries, the firms that remain at the same place will find themselves above/below the new diagonal. Such firms rely on unchanged processes, and therefore will lag behind more competitive enterprises. The introduction of flexible systems into the product-process matrix makes for an apt illustration of how firms adapting flexible systems can gain a competitive edge in a given industry. Yet we can take a different approach to the whole process, as well: firms employing flexible systems stay on the diagonal, their position remains unchanged. Those refraining from the use of flexible systems gradually leave the diagonal behind. My thesis takes the former approach: it is the firms with flexible production systems whose position changes.

[28] This state is not contained in the original matrix (see Figure 3.4), only in its later versions.

traditional mass producer towards flexible operation, that is, point C in Figure 3.4 also signifies a move away from Taylorian work organization.

Yet the contrast between traditional and lean mass producers is not the only thing that the product-process matrix can be used to illustrate. Let us consider the fact that a (lean or traditional) firm may occupy „any position" in the matrix. Depending on its position (process chosen, volume):

- the degree of the changes to be expected in work organization during the traditional-to-lean transition will significantly vary;
- the dissimilarities in work organization may be substantial even between two lean companies!

It has been proven empirically that process choice affects technical practices. Conceptually, it can also be shown that process choice has an influence on work organization. Thus it can be concluded that in connection with the lean system, decisions concerning firms' manufacturing strategies deserve serious attention, for they may influence the intensity and efficiency of use of some of lean's practices.

Propositions concerning the conclusions of empirical studies. Considerations (but only considerations!) emphasizing the significance of process choice appear in large-sample surveys of the socio-technical type, as well.

Cua et al. (2001) regard the choice between processes matching small volume-large variety vs. large volume-small variety configurations to be a type of manufacturing strategy decision. Though the product-process matrix suggests that these processes should be expected to differ in terms of HRM, too, the study does not reach any conclusions in that regard. Oliver et al. (1994) point out the high level of automatization that characterizes world-class manufacturers' processes. It is known that either the better performance or the higher level of automatization (observed at world-class manufacturers) alone would justify a more extensive use of HRM practices. The authors did not however detect a difference in terms of HRM practices.

Large-sample surveys on lean production only make references to the impact of process choice on HRM practices. Thus they fail to reveal anything concerning either the strength or the direction of such effects.

In summary, it can be concluded that the conceptual articles in the socio-technical literature of lean production (modern production systems) do emphasize the changes in the business environment, yet pay no attention to firms' competitive strategies. The empirical literature is, in accordance with the organizational logic concept, dominated by the best practice approach, manufacturing strategy decisions and goals are rarely ever mentioned (only in papers of a technical focus, if at all). The best fit approach, which underlines lean producers' differing preference of work organization model, appears in conceptual (Sakakibara et al. 1997), as well as empirical works (Youndt et al. 1996). These considerations indirectly support the elaboration of my research problem.

3.2.3. The Effect of Human Resource Management Practices on Operational Performance

The performance effect of the lean production system can be examined from two perspectives:

(1) The *operating mechanism of work organization practices* viewpoint deals with how **work organization practices lead to performance improvements** in the lean system.

(2) The *source of performance* viewpoint seeks to answer whether it is the **technical and/or the socio sub-system that drives performance improvements** in the lean production system.

My research questions call for the more detailed discussion of the papers that belong to the latter category. The works of the *source of performance* perspective are, for a large part, the very same works as those covered in Subchapter 3.2.1. Which is just logical: it is hardly possible to avoid looking into the lean production system's HRM practices if we are to analyze their performance effects.

1. Operating mechanism of work organization practices. Sparham and Sung (2007) distinguish between two parties, neither of which dispute that lean work organization improves business performance.

- According to the *win-win* camp, both the workers (e.g. better teamwork, training, skills development, commitment etc.) and the organization (e.g. improving productivity, profitability) benefit from the lean system. Identification with the win-win camp (and the underlying chain of logic) is often explicitly declared in Operations Management.
- The other camp believes the *increase in work intensity* to primarily account for any performance improvement.

The opinions of the two camps suggest that these perspectives can be related to the duality observed in the evaluation of the lean production system's impact on the workers.

I did not manage to find any empirical paper in the Operations Management literature that would investigate this perspective with respect to lean production. Ramsay et al. (2000) focused on the operating mechanisms of HRM best practices. They concluded that the argumentation of neither the win-win camp (HPWS practices), nor the second group ("labor process") can be confirmed. The part of their conclusion that lean researchers may find particularly interesting is the one that challenges the win-win argument, which, as they pointed out, has by now been taken over by the majority of managers (and the management literature) without any criticism whatsoever.

2. Source of performance. Socio-technical works on lean production have come up with a set of substantially different explanations:

1. The **bundles of technical and work organization practices jointly** (through their alignment) and synergically contribute to operating performance (MacDuffie 1995; Shah and Ward 2003; 2007).
2. It is the **work organization practices alone** that explain the results of modern production practices. Numerous authors failed to find a connection between JIT practices (Sakakibara et al. 1997) or production practices (Birdi et al. 2008; Patterson, West, and Wall 2004) and performance. Performance improvements are to

be attributed to infrastructural elements (Sakakibara et al. 1997), empowerment (Birdi et al. 2008; Patterson, West, and Wall 2004) and training (Birdi et al. 2008).

3. Improving performance is the result of production practices. This is the standpoint that is reflected in technically oriented lean studies, most of which only mention the significance of HPWS practices in passing (Losonci 2008). Yet in their socio-technical work, Oliver et al. (Oliver, Delbridge, and Lowe 1996) also concluded that **a clear relationship between work organization practices and performance does not exist** (e.g. teamwork has no influence on performance).

The literature does not question the lean system's positive impact on operational performance. In the literature of Operations Management – in accordance with the best practice approach – it is a widely accepted view that technical and socio practices jointly – synergically – improve performance. Analyses of the source of this improvement, however, brought very diverse results. The effect of neither the technical, nor the HRM practices is unambiguous. **The findings lead us to believe that technical elements alone cannot improve performance.**

3.2.4. The Effect of Human Resource Management Practices on Operational Performance – The Role of Strategic Goals

The majority of lean researchers – in line with the best practice approach – do not pay attention to the relationship between strategic goals and operational performance. Considerations related to the best fit or the synthesizing approach are only touched upon. From amongst all the papers reviewed, only three have any bearing on strategic goals.

Cua et al. (2001) point out that in modern production environments, from amongst all the contextual factors, it is only the process type that has a significant effect on performance. Low volume and a higher degree of customization lead to weaker performance, while high volume and a lesser degree of customization results in higher performance. Even though it might be assumed that process types are also related to HRM practices, the authors do not discuss that aspect.

Birdi et al. (2008) deal with strategic goals when reviewing the limitations of their research. They suggest that at innovative, niche-market producers, HRM practices will have a more significant effect on performance than production practices. Both sets of practices will be important at companies that are interested in *speed of delivery* and cost reduction. The authors do not investigate the issue, but merely allude to potential performance effects. It is not perfectly clear, either, whether it is the HRM practices considered in their study that they attribute such potential effects to.

The best fit approach appears in the article of Youndt et al. (1996). According to them, it is firms with quality-oriented strategies that use HRM practices in the appropriate way. Cost-oriented strategic goals would be better served by the administrative HRM system – firms, however, fail to take advantage of that.

Some authors examine the relationship between the existence/communication of a strategy and performance in lean/JIT environments. Findings are ambiguous. According to Sakakibara et al. (1997), strategy explains performance, while Ahmad et al. (2003) conclude that from amongst all the infrastructural elements, strategy is the only one that does not affect performance. My research deals with the strategic goals followed, and does not cover strategy development and formalization.

In summary we may conclude that in researchers' evaluations of the performance effect of the lean production system's HRM practices, manufacturing strategy goals have a marginal role. The best fit (or the synthesizing) approach hardly ever appears in the studies reviewed. Some works merely raise the issue (Birdi et al. 2008), while some are empirical in character (Youndt et al. 1996). These considerations are related to my research questions insofar as **HRM practices associated with HPWS are believed to function more efficiently at innovative firms, which follow quality goals.** Where such goals prevail, HRM practices may contribute to performance to an even greater extent than production techniques do.

3.3. Summary

Chapter 3 provided an overview of two of the focal points of socio-technical studies: the intensity of use of HRM practices and their efficiency. The effects of the business environment, and the firm's competitive strategy (competitive capabilities) and manufacturing strategy are considered, as well (Table 3.4).

Table 3.4. The business environment and strategic goals in studies dealing with the work organization of the lean production system

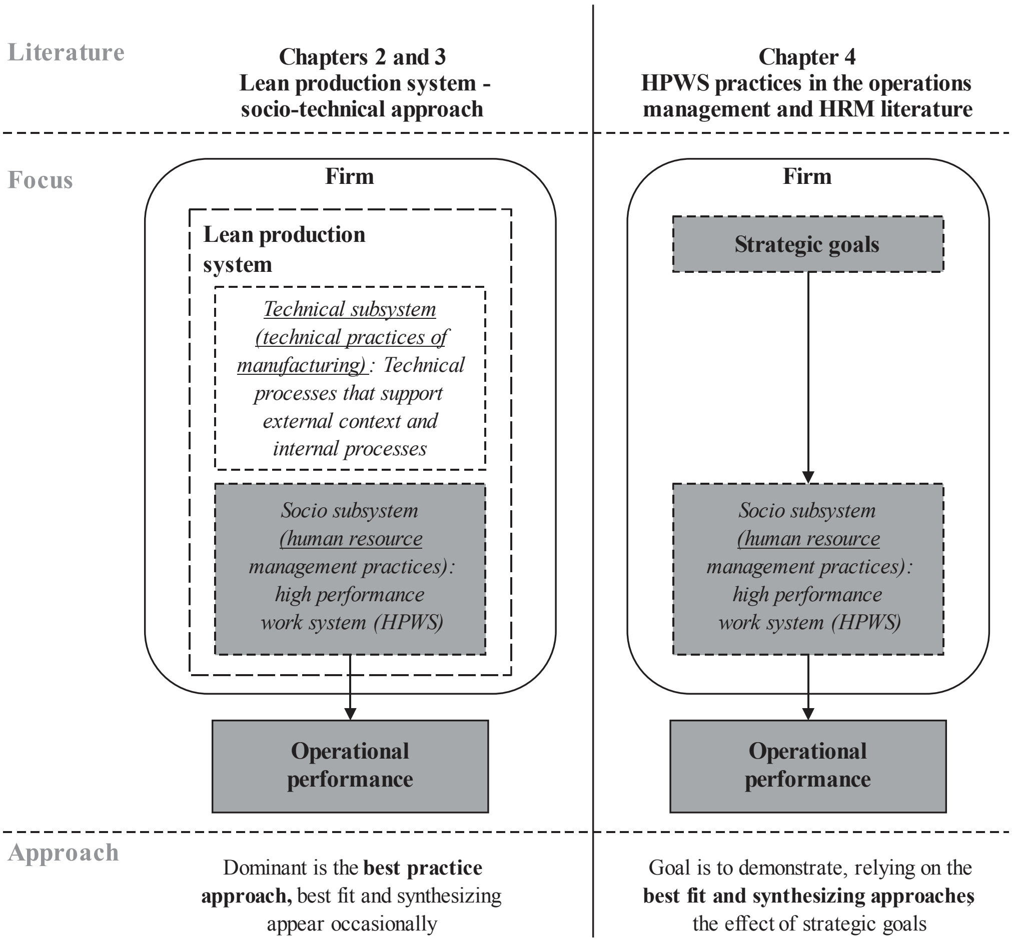
Focal point	*Main conclusion*	*Assessment of the effect of strategic goals*	*Thoughts inspirational for my research*
Intensity of use of HRM practices	- Theoretical considerations imply the extensive use of HPWS practices. - Empirical findings suggest that lean producers: (1) make extensive use of HPWS practices; (2) outperform others in problem solving and involvement practices; (3) use the same HRM practices as other types of producer do.	- It is a marginal issue in the best practice literature, scant allusions only. - The best fit approach appears both in theoretical and empirical context.	- Even among lean producers there might be differences in work organization. - Ambiguous empirical findings. - Empirical investigation of the best fit/synthesizing approach justified.
HRM practices' effect on operational performance	- The Operations Management literature primarily highlights the synergies between technical and socio practices. - Technical elements alone can most probably not improve performance.	- It is a marginal issue in the best practice literature, scant allusions only. - The best fit approach appears both in theoretical and empirical context.	- Empirical investigation of the best fit/synthesizing approach justified. - In quality-oriented/ innovative environments, HRM practices' effect may even exceed that of production techniques.

The literature is dominated by the best practice approach. There are hardly any conclusions related to strategic goals, those tend to be mentioned in brief references or conceptual considerations only. Some authors do, however, emphasize the relationship between modern production systems and manufacturing strategies (or strategic goals) (Snell and Dean 1992; Youndt et al. 1996), and call attention to the role of the environment (Lewis 2000). **The gist of the conceptual considerations and the ambiguity of the empirical findings of the best practice stream suggest that strategic goals may have an influence on the intensity of use and efficiency of lean practices.** In light of the above, researching the topic certainly appears justified.

4. Operations Management and Human Resource Management Literature

Chapters 2 and 3 discussed the literature of the lean production system. The areas with a gray background in the left-hand side of Figure 4.1 signify the focus of the part of the literature review that we have covered so far. Though the research questions could already be formulated based on what has been said so far, a review of the relevant pieces of Operations Management and HRM literature will, in my opinion, result in more well-founded questions (right-hand side of Figure 4.1).

Figure 4.1. The studies reviewed – literature, focus, approach



Chapter 4 involves sources that employ the best fit or the synthesizing approach to link the intensity of use (Subchapter 4.1) and efficiency (Subchapter 4.2) of HPWS practices to strategic objectives. Chapter 5 will provide a comprehensive summary of the present chapter and our previous conclusions about HPWS practices. Subchapter 4.3 identifies other factors that affect HPWS practices.

The literature review of Chapter 4 builds upon, for the most part, the articles identified by my systematic literature search. I am aware that Chapter 4 might have been built on a broader foundation of literature, yet I am convinced that I will still be able to elaborate on the most important relationships to sufficient detail. The best practice approach – which dominates the HRM literature, too – is not represented in this chapter (Huselid 1995; Pfeffer 1998; Pfeffer and Veiga 1999).

Chapter 4 returns to the problem already discussed in the Introduction: the differences between the business environment, the competitive capabilities that support the business strategy and manufacturing strategy goals (competitive priorities). The HRM literature is much more closely related to the Porterian sources of competitive advantage (Porter 1980; 2006; Bartek-Lesi et al. 2007). However, authors often assign different content/definitions/variables to the Porterian categories. In this chapter, I will pay very close attention to which author uses which concept. It was the inconsistent use of concepts that drove me to prefer, as I have already mentioned, the expression 'strategic goals', and to devote a separate section to the typical operationalization of strategic goals in the Operations Management field.

4.1. The Relationship Between Strategic Goals and HPWS Practices

4.1.1. The Relationship Between Manufacturing Strategy Goals and HPWS Practices – Operations Management Literature

I found two publications that deal with the relationship between manufacturing (strategy) goals and the use of HRM practices. One is a theoretical paper that follows the best fit approach, and the other is an empirical work that takes the synthesizing approach. This also confirms that the emphasis that the Operations Management literature attaches to HRM practices is out of proportion with the amount of research into the topic.

The **theoretical article** of Santos (2000) follows the best fit approach, and focuses on the relationship between manufacturing priorities (e.g. quality, delivery performance, flexibility and cost) and HRM practices. He worked on the assumption that both the production and the human function aim at supporting the firm's competitive strategy. And the competitive strategy can be supported by integrating the two functions into a coherent system that corresponds to the competitive priorities of the manufacturing strategy. Santos clearly demonstrates that **the cost and the quality goals presume differing HRM systems**. He defines the HRM practices linked to the cost and quality goals drawing from Schuler and Jackson (see Appendix 1). He associates the production of the firm that follows a quality goal with the TQM system.

In their **empirical** work, Jayaram et al. (1999) seek to identify a relationship between innovative HRM practices (senior management's commitment, communication of goals, employee training, cross-functional teams and general HRM practices) and manufacturing performance (quality, flexibility, cost and time). The article treats innovative HRM elements as best practices, and it explains the differences in the extent of their use by manufacturing goals. Their findings confirm that **the different manufacturing goals are supported by differing HRM practices**, e.g. there are „*HRM practices that support cost-reduction*" or „*HRM practices that support quality*". In other words: manufacturing goal-specific HRM practices do exist (and they have a positive impact on operational performance). Unfortunately, what the study fails to give any sort of guidance about is the content of innovative HRM practices for different goals. Their questionnaire survey is of particular interest because their respondents (N=57) are first-tier suppliers of the „Big Three"[29], which suggests the widespread use of the lean production system.

Based on the above, the relationship between manufacturing strategy goals and HRM practices of manufacturing firms definitely appears to be worth investigating. I can use the central idea of these two articles to lay the groundwork for my research questions: **HPWS practices are probably used less extensively by firms that rely on their cost advantage, and more extensively by those building upon quality (differentiators)**.

[29] A term used to refer to the three largest American car manufacturers, General Motors, Ford and Chrysler.

4.1.2. The Relationship Between Manufacturing Strategy Goals and HPWS Practices – Human Resource Management Literature

The relationship between strategic goals and HRM practices is one of the core problems of the HRM literature (Batt 2007; Boxall 2007; Wall and Wood 2005)**.**[30] Accordingly, numerous authors have researched the topic since the late 1980's, an indication of which is the pronounced representation of the contrast between the best practice and best fit approaches (Hesketh and Fleetwood 2006; Ramsay, Scholarios, and Harley 2000). First I will discuss the best fit approach, and then switch to the synthesizing approach.

4.1.2.1. Best Fit

The present subchapter provides an overview of those HPWS-related works in the HRM literature that rely on the best fit approach.

Schuler and Jackson (1987) are the authors of one of the most frequently referenced – theoretical, rather than empirical – studies. From amongst the HRM practices dealt with in the paper, I will discuss the ones that support the (Porterian – according to the authors) quality-enhancement and cost reduction strategies. **With the quality-enhancement strategy, they associate practices similar to those of HPWS** (see Appendix 1). It is this goal that they relate TQM and the employee suggestion system to, with Toyota and Honda cited as good examples. **The cost-reduction strategy is accompanied by the strict monitoring of and strong control over the employees.** They add that their description cannot be considered normative, for successful companies tend to pursue multiple strategic goals. Their study does not, however, cover the challenges that such firms have to face with respect to HRM practices.

Another classic is Arthur's (1992) empirical research, which supports the relationship between HRM and Porterian business strategies. In his argumentation *„the logic for the link between business strategies and industrial relations systems as defined above stems from the differences in the uncertainty of production tasks involved in the implementation of Cost Leadership and Differentiation business strategies*" (Arthur 1992, p. 490). **He links the cost leadership business strategy –**

[30] Boxall (2007) provides a very good overview of all the other goals that might shape a firm's HRM strategy. My dissertation exclusively concentrates on strategic goals.

associated with mass production – to cost reduction HRM strategies, and the differentiation business strategy – associated with flexible specialization (wider variety and smaller batches with a flexible technology) **– to high commitment HRM practices**.

The widely known concept of Miles and Snow (1984)[31] also involves types that bear close resemblance to the cost-leader and differentiator competitive capabilities. As the authors put it „*[a]lthough the language may be new – low-cost producer (Defender), product differentiator (Prospector), focused operation or nichemanship (Analyzer) – the overall strategic orientations are essentially the same*” (Miles and Snow 1984, p. 41–42). The quote above also shows that the strategic orientations they defined are rather close to those used in my thesis. With respect to HRM practices, Defenders and Prospectors exhibit all the differences discussed so far in this chapter.

A number of prominent works from the 1980s and ’90s highlight the best fit approach. In the mid-2000s, Legge (2006) already attaches importance to emphasizing in her theoretical paper that the „soft” model (the Harvard School) of HRM – that is, HRM as we know it today – is not the only one in existence. The „soft” model has completely pushed the „hard” model of the Michigan school into the background. Legge (2006) maintains that HRM and business strategy are closely related in both models. The „soft” model assumes that humans are a valuable resource, which becomes a source of competitive advantage on account of its commitment and the adaptability of its competencies and performance.[32] Based on the previous paragraphs of this subchapter, **the „soft” model is a close relative to the HRM practices of the differentiation strategy.** The „hard” model suggests that for the sake of cost minimization, employees ought to be managed in the same rational, impersonal fashion as any other input. **The „hard” model corresponds to the HRM practices of the cost-leadership strategy**. Based on empirical findings, Legge links these models to industry characteristics. That is, **the cornerstones of the best fit approach are the characteristics of the industry**:

[31] Previously: Miles et al. (1978).

[32] According to Bakacsi et al. (2000), the essence of HRM is that it regards humans as a valuable resource of the firm instead of a cost factor. That is, the authors identify with the „soft” approach. Accordingly, they interpret the „hard” approach to have been an earlier stage in the development of HRM.

- The „soft" model prevails in (the few) sectors that are exposed to international competition, employ advanced technologies and the products and/or services of which compete in quality. It is also present in knowledge-based industries, in organizations that pledge to the strategy of delivering high value-added products and services.
- Whenever a firm competes in labor-intensive, large-volume, low-cost industries, reason dictates that it should, from a cost minimization perspective, regard its employees as variable inputs, i.e. comply with the „hard" model.

A telling example of how much this duality can pervade the practice of manufacturing firms is the case study of Wilkinson et al. (2001). Most of the business environment attributes identified by Legge are present in the case, and all of them contribute to there being significant differences between the work organization practice of a Japanese electronics manufacturer and its Malay subsidiary. The Malay company applies the **intensification-driven** model of **lean production**, which **model does not involve HPWS practices**. The authors attribute the difference to business strategies, which in turn are determined by the role the individual plants have in the international division of labor[33]. Firms operating in Japan relocate into Malaysia those mature products of theirs that partake in a global price competition. These are then manufactured with mass production methods, in a small number of variations. In such an environment, the expectations to be met by workers' skills are rather low (e.g. very short cycle times, narrow jobs, trained to perform 2 or 3 tasks in case someone is absent). High productivity is achieved through discipline (e.g. keep to the cycle, presence, uniform). Other authors, too, question the best practice approach and also that HPWS practices would be universally applicable (Wood and Menezes 1998).

A number of empirical works support the best fit approach: HPWS practices are associated with the competitive capability of differentiation, and traditional work organization with cost-leadership. *Studies often derive differences in HRM from production tasks and quality management programs, which then again are in*

[33] The Japanese-Malay relation is, in certain regards, comparable to the role of the Hungarian economy in the international division of labor. As the article also suggests, one's position in the international division of labor is closely related to business goals, technology and HRM.

accordance with strategic goals. Lean has not, but TQM has received significant attention from researchers.[34] These findings also contribute to laying the groundwork for my research, which takes the synthesizing approach.

4.1.2.2. Synthesizing Approach

This subchapter deals with those HPWS-related works in the HRM literature that opt for the synthesizing approach.

The findings of these studies are remarkably diverse: the influence that strategic goals have on the HPWS system is less significant and unambiguous than one would anticipate conceptually.

Sanz-Valle et al. (1999) find no difference in recruitment and promotion by strategic goal, but at the same time suggest significant differences in training (in favor of quality-oriented and innovative firms), compensation (e.g. wages higher than at cost-oriented firms, but lagging behind in incentives) and employee participation (cost-oriented firms lagging behind remarkably). Guthrie et al. (2002) find a moderate relationship between the differentiation strategy and HPWS practices. They also point out that in a number of HRM practices there is no difference between cost-leaders and differentiators (e.g. group-based pay), whereas the disparity is quite pronounced in training/development. According to Bae and Lawler (2000), the involvement-based HRM strategy is not certain to work out for firms with a differentiation strategy. Ordiz-Fuertes and Fernández-Sánchez (2003) do not detect any difference according to strategy. The findings of the studies mentioned above are summarized in Table 4.1.

[34] As I have already mentioned, because of the close association of TQM with the quality-oriented strategy, not even passing references are made how cost-oriented firms might implement TQM. It raises questions, however, whether the quality awareness of cost-oriented firms may bring about a shift towards HPWS practices (and if so, which HPWS practices can be expected to appear). This dilemma is rather hard to resolve in the best fit approach.

Table 4.1. Relationship between strategic goals and HPWS practices – synthesizing approach

Author / Competitive capability	*More characteristic for cost-leaders*	*More characteristic for differentiators*	*No difference between the two competitive capabilities*
Sanz-Valle et al. (1999)	higher income	training incentives employee participation	recruitment, promotion
Guthrie et al. (2002)		training and development	group-based pay
Bae and Lawler (2000)	-	not certain that better in any regard	-
Ordiz-Fuertes and Fernández-Sánchez (2003)	-	-	found no difference at all

Source: the articles referenced in the table itself

Empirical findings **do not completely confirm the synthesizing approach.** If in anything, then it is in the areas of **training and development that differentiators have something of an edge over cost-leaders**.[35]

The articles are focused on investigating the relationship between strategic goals and HPWS practices – without any further connection with the organization, i.e. **ignoring both production and quality management.** In which regard they significantly differ from the works discussed in relation to the best fit approach. My research involves the production field in the synthesizing approach, which is a novelty in comparison to the papers reviewed.

4.2. The Effect of Strategic Goals on the Efficiency of HPWS Practices

This subchapter reviews those conclusions of the articles discussed in Subchapter 4.1 that are related to operational performance. Because of the small number of relevant articles, the Operations Management and HRM literatures will be dealt with together,

[35] In addition to works using two or three configurations, there are approaches, as well, that build upon a larger number of configurations, e.g. Sheppeck and Militello (2000) define five configurations based on their experience. Apart from quality and cost, they employ several further dimensions, which renders comparison with works limited to two or three configurations only difficult. Which is the very reason why I will not discuss these works in more detail. As a matter of fact, I did not find any more such studies, either.

whereas the subchapter will be divided into three sections: conceptual considerations, anecdotal arguments and empirical findings.

Conceptual considerations. The conceptual considerations reflect the assumptions of the best fit approach. Santos (2000) builds upon other articles on the topic: what best serves a firm's competitive strategy is if the production and HR functions are joined into a coherent system according to the firm's competitive priorities. And the same idea in Legge's (2006) words: the business strategies that the „soft" and „hard" approaches to HRM can best contribute to are different.

Anecdotal works. This is the category that includes Schuler and Jackson's (1987) paper, which takes the best fit approach. The authors illustrate their conclusions by examples. Their conclusions are not in complete agreement with conceptual considerations, for they also point out that large corporations pursue more than one strategic goal simultaneously.

Empirical works. The first one in the row of empirical works employing the best fit approach is that of Arthur (1992). According to Arthur, for a cost-reduction business strategy it is cost-reduction HRM practices, while for a differentiation (flexible specialization) strategy, it is high commitment HRM practices that can contribute to performance. Bae and Lawler (2000) distinguish between involvement-based and traditional HRM strategies. Their findings are contradictory: while the differentiation strategy does lead to better performance, it is far from certain that these firms pursue an involvement-based HRM strategy.

There are only two studies, too, that employ the synthesizing approach. Guthrie et al. (2002) establish that HPWS practices are particularly useful for firms with a differentiation strategy, and less useful for cost-leaders. Jayaram et al. (1999) underline that different manufacturing goals are supported by different innovative HRM practices. They also point out that HRM practices that serve a certain purpose may also support other goals.

All perspectives (conceptual, anecdotal, empirical) emphasize that the configuration of work organization practices may also be influenced by the technology employed. Even if some companies' strategic goals concur, there may be conspicuous differences in the HRM practices they apply (see Subchapter 4.3). Chapter 5 will provide a comprehensive summary of the present chapter and our previous conclusions about HPWS practices.

4.3 Other Factors Affecting HPWS Practices

The present subchapter introduces factors – other than strategic goals – that may have a significant influence on the use of HPWS practices. Despite the Operations Management perspective of my research, it appears important to review **these factors**, for they **raise a number of dilemmas concerning the use of HPWS practices** that **the lean literature seems prone to ignore**. This is clearly indicated by the fact that the majority of these studies do not even mention lean production. The chapter presents these dilemmas, on the one hand, to make us aware of them and, on the other hand, because they constitute the limitations of my research.

The chapter deals with four areas:

- provides a rough overview of the disputes about HPWS practices (e.g. prevalence, convergence/divergence) (Subchapter 4.3.1),
- outlines Operations Management research into HPWS practices (Subchapter 4.3.2),
- establishes whether the HRM literature regards the Japanese/lean system as an explanation for the use of HPWS practices (Subchapter 4.3.3), and
- finally, it discusses the relationship between technology and HPWS practices (Subchapter 4.3.4).

4.3.1. Debated Issues About HPWS Practices

Prevalence of HPWS practices. In the mainstream HRM literature, HPWS practices are considered to be best practices and globally present in business life. In the course of the last two decades, however, various empirical studies have established that the HPWS model is not widespread. Concerning the situation in Britain during the 1990s, Gittleman et al. (1998) write that only a few percent of all firms rely on HPWS practices. The case is quite similar for the United States (Batt and Appelbaum 1995; Roche 1999). Much later, in the mid-2000s, Legge (2006) still maintains that the practices are not used by many. Methodological (Godard 2004; Hesketh and Fleetwood 2006; Wall and Wood 2005), theoretical and empirical criticisms[36] (Wall and Wood 2005) of the studies also show that many find the scientific findings pertaining to HPWS practices debatable. They question whether scientific results indeed confirm the widespread use of HPWS practices, and whether they actually evince the contribution to profitable operation thereof. Which suggests that Godard and Delaney (1999) are quite justified in raising the rhetorical question: in light of the advantages ascribed to HPWS practices, how can this be explained?

Convergence/divergence. The convergence/divergence debate is about the convergence of and the differences between HRM practices. The argument only concerning HPWS practices, country-specific HRM practices (if they – still – exist at all) are not considered. Convergence/divergence may be influenced by differences like country of origin or the impact of trade unions (Godard 2008). The dispute also has geographical (cultural) region specific variants, and results are highly diverse there, as well. The concepts global convergence (Pudelko and Harzing 2007) and a regional convergence (e.g. developed countries, developing countries) also underline international differences (Drost et al. 2002).

From amongst the many aspects of the convergence/divergence debate, I wish to highlight the one that pertains to the country of origin of multinational corporations. Poutsma et al. (2006) **attribute explanatory power to country of origin**, while according to Pudelko and Harzing (2007), the impact of the country of origin may exhibit significant differences by country: they propose that the effect is only detectable with respect to American corporations – not for Japanese or German ones. MacDuffie and Kochan (1995) also ascribe explanatory power to country of origin. It is the country of origin effect that the authors suggest as an explanation for the significant differences detected between the training policies of automotive assembly plants. They also point out that the effect of the country of origin is mediated by firms' manufacturing strategies (i.e. the flexible manufacturing system). Their findings suggest that **production may have explanatory power relevant to the convergence/divergence dispute, as well**.

[36] As of today, worries of a similar nature have not yet been voiced with regard to lean production, whereas the socio-technical papers, which practically integrate the two areas, are often the target of criticism from the HRM literature (e.g. methodology, conclusions drawn).

Hungarian authors take a broader view in discussing the HRM challenges raised by internationalization than the convergence/divergence dispute. They cover the dilemmas appearing in international literature, but pay no attention to the production function. Póor (2006) underlines that Japanese and American firms tend to adjust to local needs to a great degree. As an example of country of origin effect, Kováts (2006) gives Japanese companies' practice during the 1980s-'90s, i.e. that managers from the home country always had a substantial role in running the subsidiaries. As regards Anglo-Saxon corporations, he gives an account of the standardized, bureaucratic and formalized framework they rely on.

The convergence/divergence dispute identifies a number of effects that may influence HPWS practices. One of them is the country of origin effect. Despite the production area receiving scant attention only, they might still aid in interpreting research findings. Closely related to the convergence/divergence topic is culture, which is the subject of the next subchapter.

4.3.2. Operations Management Research into HPWS Practices

Operations Management research into HPWS practices[37] are related to the convergence/divergence debate, and the national/cultural dimension is part of the discussion, as well.

Ahmad and Schroeder (2003) investigated the impact that country and industry have on the pattern of HRM practices. In addition to the effect of industry, they also detected differences according to **nations**. They established that at manufacturing firms, performance-based compensation directly affects operational performance, while all the other HRM practices only do so via employees' commitment. Cagliano et al. (2011) analyzed the relationship between new forms of work organization, **national culture** and the level of economic development. In addition to culture, it was the effect of company size that they found significant. Noar et al. (2010), conducting their study in another context, also underline the influence of national and **organizational culture**. They suggest that out of the two, organizational culture has the greater impact.

[37] The impact of the supply chain on work organization is discussed by e.g. Koulikoff-Souviron and Harrison (2007), but that is not strictly relevant to our topic.

Research findings imply that **nationality/national culture/organizational culture/industry** affect the HRM practices of manufacturing firms. These factors may constitute „natural" barriers to the use and efficiency of HPWS practices. Operations Management studies do not look into the effect of the lean system, nor that of strategic goals.

4.3.3. The Impact of the Japanese/Lean System on HPWS Practices – HRM Literature

It is the exception rather than the rule when a piece of HRM literature attributes explanatory power to Japanese firms or lean production for the use of HPWS. The studies I managed to uncover suggest a positive relationship: in the HRM literature, the use of HPWS practices might be explained by the (lean) production system of Japanese firms.

Wood (1996) regards the preparations for implementing the lean system as a possible explanation for the more extensive use of HPWS practices at UK firms of a Japanese origin. It is the role of quality management, among others, that Doeringer et al. (1998) refer to when pointing out that the subsidiaries of Japanese corporations are ahead of their American counterparts in terms of HPWS practices.

The above two papers show that production may well have an influence on HPWS practices. They do not, however, deal with strategic goals, beyond establishing a relationship between production/lean and HPWS.

If, in light of the above, we endeavor to answer why lean production is so rarely mentioned in the HRM literature in connection with HPWS practices (use, performance effect), there is one logical explanation that certainly comes to mind. First of all, one needs to take into account what the literature of the lean production system never misses to underline: human resources have a critical role in lean techniques. From our overview of the HRM literature, it clearly transpires that lean techniques merely constitute a technology, an „internal" contextual factor in the eyes of HRM researchers. A technology the effects of which they hardly ever analyze. Thus it appears reasonable to conclude that HRM is much more important to lean production than vice versa. Having been made aware of this fact, lean experts ought to become much more open-minded towards other fields. Though it might be an indication of increased interest from the HRM profession that in 2013 there was a call for a special issue on lean production by The International Journal of Human Resource Management.

4.3.4. The Impact of Technology on HPWS Practices

When reviewing the HRM literature, I have already mentioned that technology is a factor that may significantly influence the relationship between strategic goals and HRM practices.

According to Boxall (2007), technology may give rise to remarkable disparities in HRM practices even if the strategic goal (e.g. cost-leadership) pursued is the same. **Labor-intensive manufacturers**, who rely on technology to a smaller degree (*low-technology manufacturing*) strive to keep their labor costs – a vital competitive factor for them – at the lowest possible level. The corresponding HR strategy is presented in the left-hand side column of Table 4.2.

Table 4.2. The impact of technology on Human Resource Management

Main characteristics of the technology	*Low technological level, often labor-intensive, high volumes*	*High technological level or highly capital-intensive, workforce often small, but comprised of specialists*
Business strategy	cost-leadership	cost-leadership
Main attributes of Human Resource Management	- this environment involves competing in labor costs, thus HR strategy is dominated by the need to survive - firms seek low-wage plants that deliver high output levels and acceptable quality - the wages paid correspond to the local labor market, additional benefits or high training expenditure are far from typical	- due to the need to capitalize on their technological edge, firms HR strategies are based on employee development and motivation (helps achieve cost-leadership) - high wages, high qualification model of workforce management – both serve to keep costs low - investment into HPWS becomes justifiable

Source: Boxall (2007, p. 48–68)

Capital-intensive technologies require different HRM practices, even if the business strategy aims at cost-leadership. Firms that employ capital-intensive technologies **are more likely to adapt HPWS practices, even if they pursue cost-leadership** (right-hand side column in Table 4.2).

Walton's (1985) call for attention to the relationship between HPWS practices and technology came, however, much earlier. He examined continuous flow processes, which demand a completely different type of employee (qualification, tasks, headcount) than mass production does (see Chapter 3). He pointed out that continuous flow processes and HPWS practices are a very good match. Boxall's conclusions, too, can be explained by the choice of process type.

Unfortunately, the researchers analyzing the impact of technology fail to say anything as to how quality management programs that presume HPWS or the lean production system could be linked to strategic goals. Their findings represent a finger raised in warning that firms employing continuous flow processes need to be dealt with separately in HRM research.

An earlier study I co-authored also looked into – in passing – the impact of automatization. We observed that in a mass production environment (process system), automatization may even lead to a decline in the qualification level (Losonci, Demeter, and Jenei 2011), whereas the firm under scrutiny strived to introduce the HPWS system as a preliminary to switching to the lean production system. Which conveys the message that the HR management of mass producers may even have to cope with the presence of conflicting incentives.

The use of HPWS practices may be significantly influenced by culture (country of origin, destination country, organizational) and industry. These two are, at the same time, factors that rarely ever receive due attention in Operations Management and the portion of its literature on lean production. My research is limited to developing an understanding of the relationship between lean production and strategic goals. The investigation of these factors in a lean environment is left for future research. The established models of culture research (e.g. GLOBE) are perfectly suited for the purpose.

5. Manufacturing Strategy Goals and the Lean Production System – Research Questions and Methodology

In the literature of lean production, there appears to be a need for research into the factors that affect the lean production system. The present paper investigates **the relationship between manufacturing strategy goals and the socio subsystem** on a sample of lean producers. Manufacturing strategy goals are linked to competitive priorities, of which two are discussed in detail: cost-leadership and differentiation. The socio subsystem of the lean production system is built on HPWS practices.

In Operations Management, the two most widespread manufacturing strategy goals have for long been cost-leadership and differentiation (Roth and Miller 1994; Frohlich and Dixon 2001). Because of the varied operationalizations and the continuously changing content (i.e. which combination of order-winning criteria they are made up of) of manufacturing strategy goals, it is essential that my research define the content of these two manufacturing strategy goals. This is particularly important as the crisis might have left its mark on the sample my analysis relies on (data collection in 2008 and 2009). I could not find a comprehensive analysis on manufacturing strategy goals in the literature from the late 2000s and the period of the crisis. Accordingly,

Research Question 1: How should the cost-leader and differentiator manufacturing strategy goals be interpreted in the end of the 2000s, based on our sample of manufacturing firms?

However, the analysis of manufacturing strategy goals not being the focus of my research, the related literature review was of lesser priority. The literature of manufacturing strategy goals will be reviewed in connection with operationalization (Subchapter 6.2.4) and the interpretation of results (Subchapter 7.4.1).

Having answered Research Question 1, I will proceed to **investigate on our sample of lean manufacturers whether there is a difference in…**

Research Question 2: the intensity of use of HPWS practices

Research Question 3: the effect that HPWS practices have on operational performance

by manufacturing strategy goal.

The conceptual considerations and empirical findings on which Research Questions 2 and 3 rest can be summarized as follows:

1. **The socio-technical literature of the lean production system is dominated by the best practice approach.** The literature **rarely engages in the analysis of strategic goals**, even though several renowned research urge the investigation of the relationship between lean production and strategy. A number of empirical works failed to confirm that lean producers make more extensive use of HPWS practices. There is no consensus, either, over the role HPWS practices have in improving performance. Apart from these shortcomings of the empirical findings, numerous conceptual considerations, as well, indicate that strategic goals may be of significance.
2. The **best fit approach associates HPWS practices with the differentiation strategy**. Whereas a wide spectrum of Operations Management and HRM papers suggest that this dichotomy is still valid, the approach is represented in the lean literature only conceptually (e.g. Sakakibara et al. 1997). Researchers link differentiation to factors like uniqueness, TQM, quality management, flexible specializations, wide variety, small batches, international competition, technology-intensive processes, quality-based competition and high value-added. The characteristics of cost-leaders, which pursue traditional work organization practices, are low-cost production, large volumes, small variety and mass production. I managed to find only one empirical study on modern production systems (Youndt et al. 1996) the concept of which seems possible to apply to lean production. Many empirical/anecdotal works support that cost-leaders employ traditional work organization methods, which indirectly implies that HPWS practices carry less weight in such organizations.
3. The **synthesizing approach** presumes that **firms with a differentiation strategy may be expected to make more intensive and efficient use of HPWS practices**. Operations Management research has provided scant evidence for this presumption

(Jayaram, Droge, and Vickery 1999). The HRM literature, as well, suggests that the influence of strategic goals is real, if limited in scope: differentiators are slightly ahead in terms of training and development. HRM literature pays as good as no attention at all to the potential impact of the production system/process.

The best fit and the synthesizing approaches **agree that the use of HPWS practices is only justified if the firm pursues a differentiation strategy**. They expect a **cost-leadership strategy** to be accompanied by different HRM practices – **i.e. they concur that HPWS practices are pushed into the background.** Table 5.1 summarizes the relationship between the individual approaches and HPWS practices.

Table 5.1. The relationship between (the intensity of use and efficiency of) HRM practices and strategic goals

<table>
<tr><th colspan="2">Approach</th><th rowspan="2">Best practice (lean literature)</th><th rowspan="2">Best fit</th><th rowspan="2">Synthesizing approach</th></tr>
<tr><th colspan="2">Competitive capability (competitive priority)</th></tr>
<tr><td rowspan="2">Assumptions of approach</td><td>Cost-leader</td><td rowspan="2">HPWS practices</td><td>Traditional model (close to the Taylorian model)</td><td>more limited use of HPWS practices</td></tr>
<tr><td>Differentiator</td><td>HPWS practices</td><td>more extensive use of HPWS practices</td></tr>
<tr><td colspan="2">Findings from the literature review</td><td>- dominant approach
- numerous conceptual considerations suggest the usability of the other approaches
- ambiguous empirical findings</td><td>- supported by empirical studies (one of them from the Operations Management field)
- conceptual considerations
- quality management and production present in HRM research</td><td>- ambiguous empirical findings: differentiators ahead in training and development
- one theoretical paper from the Operations Management field
- no attention to production in HRM research</td></tr>
<tr><td colspan="2">Literature</td><td>Operations Management literature dealing with lean production management</td><td colspan="2">Operations Management and HRM literature</td></tr>
</table>

Another important conclusion from the literature review is that the relationship between strategic goals and the use of HPWS practices is more widely discussed than the effect of strategic goals on the efficiency of HPWS practices.

Relying on the assumption of the synthesizing approach, we may expect **HPWS practices to have an important role in lean producers' operation, irrespective of the manufacturing strategy goal they pursue.** My research questions and expectations are the following (Figure 5.1):

Research Question 2: How do manufacturing strategy goals influence the intensity of use of HPWS practices in a lean environment?
Expectation: Lean producers with a differentiation strategy make more intensive use of HPWS practices than those with a cost-leadership strategy.

Research Question 3: How do manufacturing strategy goals affect the contribution of HPWS practices to operational performance in a lean environment?

Expectation: Lean producers with a differentiation strategy are more efficient in using HPWS practices than those with a cost-leadership strategy.

My expectation is that **in comparison to lean producers with a differentiation strategy, lean producers pursuing a cost-leadership strategy use HPWS practices less intensively and less efficiently.**

Hypothesis testing is done using statistical methods and multivariate statistical analyses.

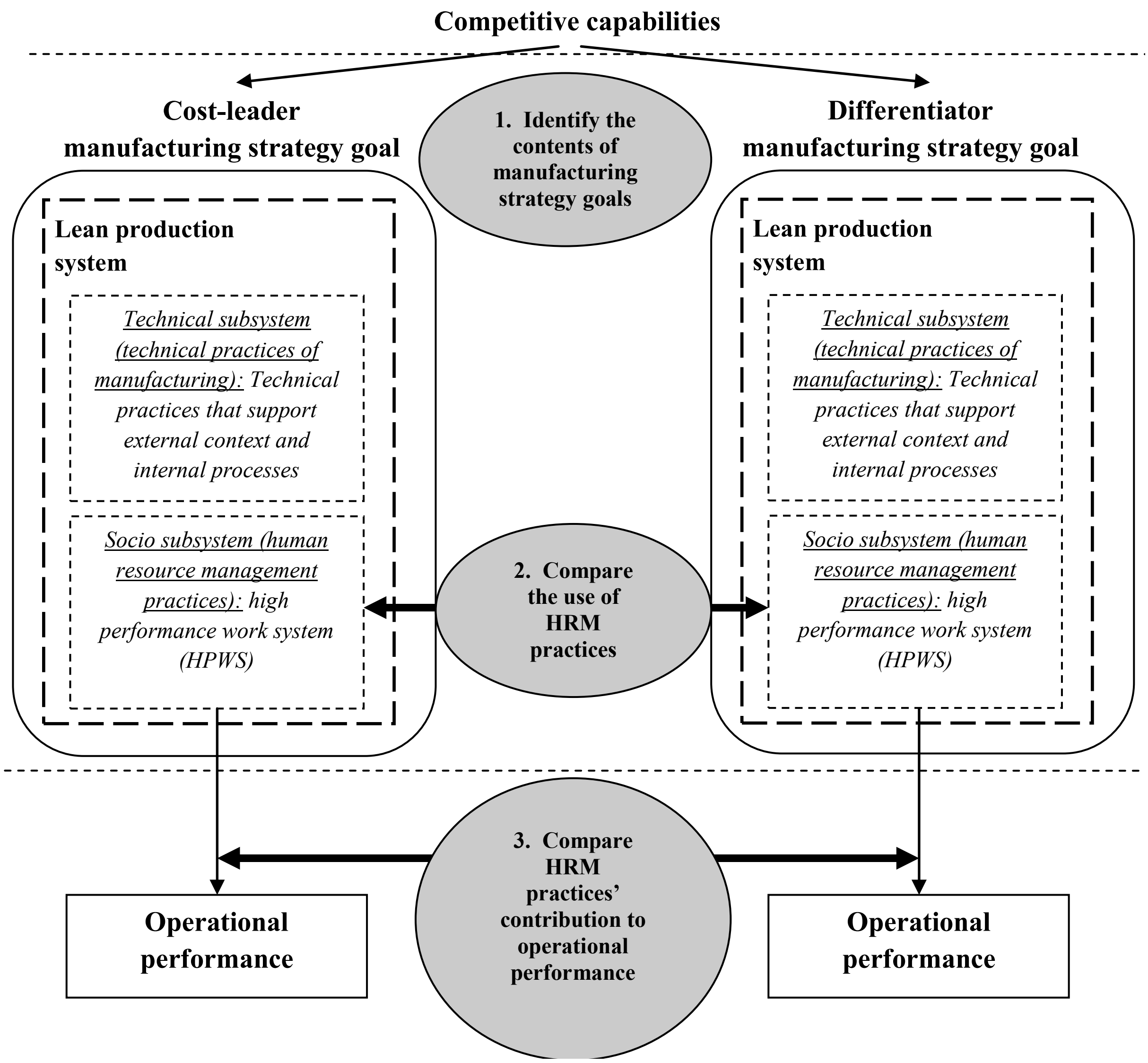
As concerns Research Question 1, the two manufacturing strategy goals (cost-leader and differentiator) will be defined by means of a cluster analysis.

Research Question 2 examines the intensity of use of HRM practices according to manufacturing strategy goals. The intensity of use of HRM practices of the two groups of lean producers – pursuing different manufacturing strategy goals – can be compared using ANOVA analysis.

Research Question 3 investigates how HRM practices affect operational performance indicators for differing manufacturing strategy goals in a lean environment – or, in other words: the moderating effect of manufacturing strategy goals. A moderator variable typically is „*a qualitative […] or quantitative […] variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable*" (Baron and

Kenny 1986 p. 1174). The moderating effect will first be analyzed using group comparisons, and next I will also examine the interaction effect, particularly widespread in works taking the contingency theory approach (Venkatraman 1989).

Figure 5.1. Research Questions – Intensity of use and efficiency of HPWS practices at lean producers with differing manufacturing strategy goals



Baron and Kenny (1986) maintain that viable analytic procedures differ by the level of measurement of the independent and the moderator variables, and present four potential methodologies. I will follow the considerations of Venkatraman (1989), who outlines two possible ways of analysis: he distinguishes between investigating the strength and the form of the moderating effect.

Generally speaking, a precondition for analyzing moderating effects is that the moderator and the predictor be of a similar level, i.e. no causal relation between the two, both being independent variables. Another desirable condition is that the moderator variable should not correlate with either the predictor or the dependent variable. One should be very careful about multicollinearity (between the moderator and predictor variables) when using the *moderated regression analysis* method.

Moderated regression analysis has been applied by a number of earlier studies. For example, Youndt et al. (1996) relied on multiple strategic goals and Human Resource Management systems per observational unit, all measured on continuous scales. Dabhilkar and Ahlstrom (2013) also employed continuous scales for both STS and lean production.

6. The Survey and its Variables

6.1. The IMSS Survey

The empirical part of my research relies on data from the International Manufacturing Strategy Survey (IMSS). IMSS is an international research network that aims at exploring the main attributes of manufacturing strategies, and studying the implementation and the performance effects thereof. The network was brought to life in 1992 as a joint initiative of London Business School and Chalmers University of Technology. The administration of the survey is done by local research groups – simultaneously in each round. Through the contribution of Krisztina Demeter and Attila Chikán, researchers of the Department of Logistics and Supply Chain Management (and its predecessors) at Corvinus University of Budapest, Hungary has been part of the research project right from the start.

The questionnaire is filled in by the *director of operations/manufacturing* or an employee of a similar position. The data in the survey also contain information about the *corporation* itself, but for the most part they pertain to the *business unit* headed by the manager in question. The majority of the variables are *perceptual measures*, even though *objective measures* would be more desirable, e.g. ppm for evaluating quality. The survey is based on *self-reported data*.

My research relies on data from the fifth round of IMSS. Matyusz (2012) and Demeter (2000) both provide an overview of the survey itself, its execution and the earlier rounds. IMSS involves manufacturing firms from the ISIC sectors 28-35. The sample of the fifth round comprised 725 corporations (plants) from 21 countries. Central Europe is represented by Hungary and Romania (Table 6.1).

The fifth round of IMSS, which was carried out in 2009/2010, and its results with respect to Hungary are presented by Matyusz and Demeter (2010, 2011).

Table 6.1. The fifth round of IMSS: countries and industries

	Country	# of plants	%
1.	United States of America	48	6.6%
2.	Belgium	36	5.0%
3.	Brazil	37	5.1%
4.	Denmark	18	2.5%
5.	South Korea	41	5.7%
6.	United Kingdom	30	4.1%
7.	Estonia	27	3.7%
8.	Holland	51	7.0%
9.	Ireland	6	0.8%
10.	Japan	28	3.9%
11.	Canada	19	2.6%
12.	China	59	8.1%
13.	Hungary	71	9.8%
14.	Mexico	17	2.3%
15.	Germany	38	5.2%
16.	Italy	56	7.7%
17.	Portugal	10	1.4%
18.	Romania	31	4.3%
19.	Spain	40	5.5%
20.	Switzerland	31	4.3%
21.	Taiwan	31	4.3%
Total		**725**	**100%**

Manufacturing activity (ISIC)	# of plants
Manufacture of fabricated metal products (28)	242
Manufacture of machinery and equipment (29)	185
Manufacturing of office, accounting and computing machinery (30)	12
Manufacture of electrical apparatus and machinery n.e.c. (31)	92
Manufacture of radio, television and communication equipment and apparatus (32)	42
Manufacture of medical, precision and optical instruments, watches and clocks (33)	42
Manufacture of motor vehicles, trailers and semi-trailers (52)	52
Manufacture of other transport equipment (35)	34
Missing data	24
Total	**725**

The IMSS survey is well-suited for the analysis of each of my four target topics. Data from the IMSS survey have been used in lean production, work organization and manufacturing strategy research before. In order to support the above statement, I would like to highlight some of the relevant papers published in international Category A journals:

- Demeter and Matyusz (2011) analyzed the relationship between lean production and inventory turnover on the database of the fourth round of IMSS. Consequently, the questionnaire is **suitable for identifying lean production techniques**.

- Cagliano et al. (2011) looked into the new forms of work organization, relying on data from the fourth round. Accordingly, the questionnaire is **suitable for identifying HPWS practices**.
- In the course of the last fifteen years, a number of studies on manufacturing strategy, too, relied on the survey as a source of data (Crowe and Brennan 2007; da Silveira and Sousa 2010; Demeter 2003; Frohlich and Dixon 2001). The questions are, thus, **suitable for identifying manufacturing strategy goals.**

Their analysis being particularly common, I refrain from highlighting performance indicators. There were no substantial changes between rounds 4 and 5 to the questions relevant to my research.

The questionnaire was designed to explore various aspects of the production function. Accordingly, certain limitations apply to its use in in-depth analyses of individual specialized topics. As far as operationalization is concerned, this means, for instance, that there is only one question about maintenance, whereas a lean-focused questionnaire may contain as many as 4 or 5 maintenance-related questions, possibly even inquiring about the daily routine. As also evinced by the review of the articles listed in Table 6.2 (attached spreadsheet, worksheet 'Details on the articles'), Operations Management researchers often resort to using lean management related questions taken from a questionnaire of a more general character, which is exactly what I intend to do.

6.2. Operationalization

De Menezes et al. (2010) establish that the practices researchers categorize as lean techniques are often methods related to production, work organization, quality management, logistics, supply chain, customer satisfaction, efficient delivery and continuous improvement. Others point out that it differs from study to study which ones of these practices and with what content are used to measure the lean production system (Shah and Ward 2003). Drawing upon my review of the literature, I propose the following clarification to the above statements: **the specific problem to be researched has a decisive influence on the set of variables (practices) used to operationalize the lean production system**.

Adjusting the set of variables used to describe the lean production system to one's research focus raises some serious concerns. Technical practices tend to be over-represented in Operations Management papers. Accordingly – and unfortunately –, it is only with respect to research topics that rely on the socio-technical approach that the assertion of de Menezes et al. (2010) holds true, according to which the use of the lean system demands the integration of Operations Management and HRM practices. Which is the very reason why **I relied on the socio-technical literature in defining the variables employed to capture the socio and technical practices of the lean production system and the variables pertaining to operational performance indicators**.

The most important characteristics of the empirical literature used to define the variables are summarized in Table 6.2, while a detailed overview is provided in the attached spreadsheet, along with the description of the process of defining the variables. Each worksheet presents one step of the process, a brief overview of which follows below (Figure 6.1).

First, I classified the literature into three categories (Table 6.2). The first group was comprised of large-sample empirical studies employing the socio-technical approach (1-15). Apart from the ones listed here, I did not find any further works that would belong to this group. It was these articles that I relied on in defining the variables (technical practices, HRM practices, indicators of operational performance). The second group contained two important theoretical papers (16-17), whereas the third category was for socio-technical studies (18-20) that were not as tightly focused on HRM issues as those in the first group, and were not necessarily questionnaire surveys, either (e.g. Lewis 2000).

Groups 2 and 3 are meant to demonstrate the „theoretical validity" of the variables derived from the articles in the first group. Any variables that were featured in some article from groups 2 or 3, but did not appear in the first group were not used. In consideration of Table 6.2, it can be seen that this did not lead to any variable being omitted completely, one or two measurement alternatives per variable were affected at most.

As a first step, in each article I identified the variables relevant to my research questions (worksheet 'Square One'). I strived not to narrow down the spectra of interpretation of the variables so identified. It was only the most closely related variables that I merged under a single name. Accordingly, supplier-related or lean production practices, for instance, were listed with the names used in the respective source studies.

Figure 6.1. Definition of the variables

Step	Action performed	Details
1	Identification and classification of relevant socio-technical papers: empirical and theoretical works	Table 6.2, spreadsheet
2	Listing one by one all variables from the articles that are relevant to the research questions, e.g. 44 lean production techniques, 49 HR elements	spreadsheet, worksheet 'Square One'
3	Forming groups from the variables, e.g. assigning the 44 lean production techniques to suppliers, customers, internal techniques, maintenance, quality etc.	spreadsheet, worksheet 'Refine/1'
4	Stepwise merging of the variables of similar contents through further iterations, highlighting the most frequently appearing variables	spreadsheet, worksheets 'Refine/2', 'Variables kept' 'Aggregation'
5	Defining the variables used in the socio-technical literature	Table 6.2, spreadsheet, worksheet 'Table'

The next step was to merge practices of similar contents and assign them to a more abstract category (worksheet 'Refine/1'). For instance, the practices that captured the various dimensions of supplier relations were combined into a single category. Another category was comprised of lean production techniques (maintenance, production, quality).

Based on the likeness between certain variables, I performed further iterations to merge similar practices and indicators (worksheets 'Refine/2' and 'Variables kept') – like the various practices of training, employee involvement or compensation policy. Table 6.2 shows the final result of the merging process, listing the dimensions of lean production and operational performance indicators in an „aggregate" form (worksheets 'Aggregation' and 'Table'). The original variables from the source articles may be interpreted as alternatives for measuring the „aggregate" dimension. Beyond each „aggregate" variable, there is a multitude of such alternatives and a wide range of differing interpretations. Table 6.2 endeavors to present this diversity in a perspicuous fashion.

As Table 6.2 evinces that the **technical practices of significance are, in addition to the internally-oriented ones, those related to supplier and customer relations**. Concerning the external context, it was information sharing, quality, partnership and JIT that were found to have an important role. From amongst the usual internal practices, lean production techniques and quality-related programs were dominant. Maintenance, in contrast, was less popular. Product design and production planning appear several times, as well – even though the theoretical articles did not attribute important roles to them. The frequent appearance of product design stems from several research projects having linked the lean/JIT system to modern production systems (including AMT). Today AMT does not typically qualify as lean management any more, therefore the product design variable will be omitted from my empirical analyses.

The order of importance is less clear with respect to HRM practices. **Training, recruitment, decentralization and quality, and teamwork** are among the most frequently investigated elements. Conceptual considerations imply that some further variables (job enhancement, income, hierarchy, communication) also constitute important elements of the HPWS system, yet these were less frequently represented in the studies considered. It was one of the HRM practices, too, the operationalization of which I found to be the most varied (income).

Operational performance indicators were classified into four groups. The indicators featured in the studies are those related to the well-known set of competitive capabilities: **quality, cost, time and flexibility**. Table 6.2 shows that not all of the studies dealt with this topic.

The difficulty experienced in assigning some of the practices to one specific subsystem follows from the very modus operandi of the lean system. It implies a close relation between the practices identified that decentralization and quality, and teamwork and quality often appeared together. Quality circles may belong to either the technical part of production organization, or work organization (the spreadsheet reveals which author decided for which). For the purposes of my research, quality circles are considered a work organization practice.

The articles used also associate a host of other factors with lean production – communication characteristics, managerial behavior, strategic directions or HR „performance variables" (like absence) etc. These I only recorded at the outset, but did not use them in deriving the variables, for they are not closely related to either lean production techniques or HRM practices.

It was at the time of writing the final version of my thesis that I encountered the work of Dabhilkar and Ahlstrom (2013) (article nr. 15 in Table 6.2). The article fits well into the structure I devised. It is only listed in the spreadsheet on the worksheets 'Refine 1', 'Refine 2' and 'Table'.

I will now proceed to identify in the questionnaire of the fifth round of IMSS the variables that correspond to the ones listed in the first column of Table 6.2.

Table 6.2. Operationalization of the variables in earlier studies

	Socio-technical approach - HRM focus (or significant emphasis on HRM)															Theo-retical (STS)		Lean production (STS)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Technical practices																				
Supplier relations (JIT, supplier development, quality assurance, long-term partnership)	X	X	X			X				X	X	X	X	X		X		X		X
Customer relations (JIT, customer involvement, long-term partnership)			X	X		X				X	X		X	X		X				X
Internal practices																				
Production techniques (JIT, cell, kanban, flow, changeover)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Quality (TQM, continuous improvement, quality improvement programs)	X	X	X	X	X	X		X	X	X		X				X		X	X	X
Maintenance (TPM)	X	X	X	X						X		X			X	X		X	X	X
Design (CAD, CAM, CIM)		X	X	X					X	X		X	X	X				X		
Production planning (accuracy)	X		X	X						X	X									
HRM practices																				
Decentralization (involvement, autonomy)			X	X	X	X				X		X	X	X		X				X
Quality (quality circles, employee suggestion system)			X	X	X	X			X		X				X	X	X			
Job enhancement, rotation, job enlargement (e.g. maintenance, ordering, SPC)				X	X						X	X			X			X	X	
Training (e.g. skills, problem solving)	X	X	X		X		X		X	X	X	X	X	X			X		X	
Recruitment	X	X	X		X		X		X	X	X	X					X		X	
Teamwork	X		X	X	X	X					X		X	X	X	X	X	X	X	
Communication (feedback, quality feedback)		X	X	X						X	X				X	X	X			
Hierarchy			X															X		
Compensation (knowledge-based, performance evaluation, both individual- and team-level)		X	X		X		X										X	X		

	Socio-technical approach - HRM focus (or significant emphasis on HRM)															Theo-retical (STS)		Lean production (STS)		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Operational performance indicators																				
Quality (e.g. conformance, rejects)			X		X		X	X			X							X	X	
Cost (production cost)										X	X								X	X
Flexibility (volume, variety)										X	X									
Time (e.g. delivery performance, lead time)			X				X			X	X	X							X	
Productivity			X		X	X	X					X	X	X					X	

Source: (1) Ahmed et al. (1991); (2) Snell and Dean (1992); (3) Oliver et al. (1994); (4) Forza (1996); (5) MacDuffie (1995); (6) Oliver et al. (1996); (7) Youndt et al. (1996); (8) Power and Sohal (2000); (9) Snell et al. (2000); (10) Cua et al. (2001); (11) Ahmad et al. (2003); (12) Patterson et al. (2004); (13) Birdi et al. (2008); (14) de Menezes et al. (2010); (15) Dabhilkar and Ahlstrom (2013); (16) Sugimori et al. (1977); (17) Huber and Brown (1991); (18) Lewis (2000); (19) Shah and Ward (2003); (20) Shah and Ward (2007)

6.2.1. Lean Production Techniques

For the sake of simplicity, in the subsequent analyses I will only use a certain subset of those practices of lean production that are directly connected to internal processes. Product design and production planning, though internally-oriented, will not be considered, and neither will the external context (supplier, customer relations) altogether. The simplification – which does not affect HRM practices (i.e. the focus of my research) at all – will probably render the analyses less difficult by reducing the number of lean production related variables. As evinced by Table 6.2, such procedure is not without precedent (Youndt et al., 1996; Power and Sohal, 2000; Dabhilkar and Ahlstrom, 2013).

Table 6.3 shows that each classic lean production technique (pull production, process focus, cells), as well as quality (TQM, quality circles) and maintenance (TPM) are covered by the questionnaire, with a couple of questions each.

Table 6.3. Operationalization of internal lean production practices in the IMSS questionnaire

Internal lean practices	Corresponding question in the IMSS questionnaire (nr. of the question)
Production techniques (JIT, cell, kanban, flow, changeover)	(PC4) Indicate degree of the following action programs undertaken in the last three years. 1 – none; 5 – high (b) Restructuring manufacturing processes and layout to obtain **process focus** and streamlining (e.g. reorganize plant-within-a-plant; cellular layout) (c) Undertaking actions to implement **pull production** (e.g. reducing batches, setup time, using kanban systems)
Quality (TQM, continuous improvement, quality improvement programs)	(Q2a) Indicate the effort put into implementing the following action programs in the last three years. 1 – none; 5 – high **Quality improvement** and control (e.g. TQM programs, six sigma projects, quality circles)
Maintenance (TPM)	(Q2b) Indicate the effort put into implementing the following action programs in the last three years. 1 – none; 5 – high Improving equipment productivity (e.g. **TPM** (Total Productive Maintenance) **programs**)

Note: the expression hereinafter used to refer to the given question (variable) is **underlined and printed in bold type**

6.2.2. Human Resource Management Practices

I strived to involve the broadest possible range of the HRM practices appearing in socio-technical works – to all intents and purposes: HPWS system elements – in the dissertation. Table 6.4 shows that the IMSS questionnaire features questions about a large number of HRM practices: decentralization, quality, changes to jobs, training, teamwork, hierarchy and compensation are all addressed with one or two questions each.

Table 6.4. Operationalization of the practices of lean's socio subsystem in the IMSS questionnaire

HRM practices	Corresponding question in the IMSS questionnaire (nr. of the question)
Hierarchy	(O1) How many **organizational levels** do you have (from plant manager to blue collar workers included) ______
Compensation (knowledge-based, performance evaluation, both individual- and team-level)	(O4a) On average, what proportion of your shop-floor employees' compensation is based on **incentives**? ________% of compensation
	(O4b) Indicate the usage of incentives (select all relevant alternatives): (1) **Work Group incentive** (2) **Individual incentive** (3) **Companywide incentive**
Quality (quality circles, employee suggestion system)	(O5) To what extent are employees **involved in** product or **process improvement** initiatives? 1- no involvement; 5 – continuous, deep involvement
	(O11c) Indicate the effort put into implementing the following action programs in the last three years. Implementing **continuous improvement** programs through systematic initiatives (e.g. kaizen, improvement teams) 1 – none; 5 – high
Teamwork	(O6) What proportion of your total workforce works in teams? (a) In **functional teams** ____ % (b) In **cross-functional teams** _____ %
Training (e.g. skills, problem solving)	(O7) How many hours of **training** per year are given to the regular work-force? .... hours per employee
	(A6) Approximately what proportion of the business unit **annual sales** is invested in (average % of total sales): (c) **training** and education __________ %
Job enhancement, rotation, job enlargement (e.g. maintenance, ordering, SPC)	(O8) How many of your production **workers** do you consider as being **multi-skilled**? ________ % of the production workers
	(O9.) How frequently do your production workers **rotate** between jobs or tasks? 1 - never; 5 – very frequently
Decentralization (involvement, autonomy)	(O10) To what extent is your workforce autonomous in performing tasks? 1 – no **autonomy**; 5 – high autonomy
	(O11a) Indicate the effort put into implementing the following action programs in the last three years. Increasing the level of **delegation** and knowledge of your workforce (e.g. empowerment, training, autonomous teams) 1 – none; 5 – high

Note: the expression hereinafter used to refer to the given question (variable) is **underlined and printed in bold type**.

A number of HRM variables of importance from a lean point of view are, however, not represented in the questionnaire. In the course of my review of the empirical literature, I identified a couple of HPWS practices (communication, recruitment) that are not addressed by the IMSS questionnaire, and the same applies to some of the HRM practices contained in the socio-technical model of lean production (reciprocity, and employment security and equality within).

6.2.3. Operational Performance

I strived to involve in the dissertation the broadest possible range of operational performance indicators appearing in socio-technical works. These performance indicators can be said to also dominate the technically oriented portion of the lean literature (also see e.g. the overview of Demeter et al. (2010) p. 48).

As Table 6.5 shows, the IMSS questionnaire is suitable for tracking changes in firms' performance according to all five indicators: quality, cost, flexibility, time and productivity. Some of them are covered by a single question only (e.g. cost, productivity), while the others are addressed by at least two questions each.

Table 6.5. Operationalization of operational performance indicators in the IMSS questionnaire

Operational performance indicators	Corresponding question in the IMSS questionnaire* (nr. of question)
Quality (e.g. conformance, rejects)	(aa) Manufacturing conformance (ba) Product quality and reliability
Flexibility (volume, variety)	(da) Volume flexibility (ea) Mix flexibility
Cost (production cost)	(ka) Unit manufacturing cost
Time (e.g. delivery performance, lead time)	(ia) Delivery speed (ja) Delivery reliability (ma) Manufacturing lead time (pa) Inventory turnover
Productivity	(oa) Labor productivity

*B10. How has your operational performance changed over the last three years? Compared to three years ago the indicator has: Deteriorated more than 5%, Stayed about the same -5%/+5%, Improved 5-15%, Improved 15-25%, Improved more than 25%

6.2.4. Manufacturing Strategy Goals

The literature of lean production is not concerned with manufacturing strategy goals. There are some references to the external environment in general, e.g. changes in the general environment put quality, flexibility and involvement in the spotlight. The studies reviewed do not provide sufficient guidance with regard to manufacturing strategy goals, either. The individual papers interpret the concept of strategy on differing levels, and capture it in highly varied ways (what is more, some papers concerned with strategies lack in transparency with respect to operationalization). In addition to

- production-related indicators (e.g. a manufacturing performance (Jayaram, Droge, and Vickery 1999),

strategy is also linked to

- competitive priorities (Youndt et al. 1996),
- competitive strategy (e.g. the Porterian category (Arthur 1992)),
- financial and market position (Guthrie, Spell, and Nyamori 2002),
- and sometimes even contingencies (e.g. character of the product or process, knowledge and work, and market attributes in the case of Legge (2006)).

Apart from the lack of a uniform position, it is also apparent that the HRM literature's interpretation of strategic goal goes beyond the boundaries of production, and is primarily concerned with business strategy goals.

Subsequently, I turned to the Operations Management literature in hopes of a solution for operationalizing manufacturing strategy (see Table 6.6). Yet what I found was, once again, a disturbing diversity of variables. A good illustration of this embarrassment of riches is the fact that with regard to manufacturing strategy, Kim and Arnold (1996) list 15 competitive capabilities, 32 manufacturing goals and 25 improvement action programs. The variables that the empirical studies use (either individually or in sets) come from one of the following areas: *competitive priorities, order-winning criteria, action programs, market characteristics, manufacturing goals, production performance, market orientation, complexity of (production) processes.* Table 6.6 makes the lack of a mature position clearly apparent. What is more, studies on modern production systems/quality management also involve contextual elements like product attributes (customization vs. mass product), qualifying and winning criteria, and the production process (volume, variety, process type, batch size, customization) (Sousa and Voss 2001).

Table 6.6. Operationalization of strategic goals in the Operations Management literature

Approach	Source	Variables
	BUSINESS STRATEGY	
Market-oriented approach	**Santos (2000)**	**e.g. offer the product/service at the lowest possible cost; differentiating the product; ensuring adequate technical support; building and improving product and company image; producing agile products; guarantees for delivery times; providing spare parts as part of technical support; changing the product design or quickly launching new products; wide product variety; quick changes to production volumes**
	MANUFACTURING STRATEGY	
Competitive priorities	Miller and Roth (1994) Frohlich and Dixon (2001)*	e.g. low price; design flexibility; wide product variety; volume flexibility; conformance quality, performance quality, delivery speed, delivery dependability, after-sales services
	Youndt et al. (1996)	**used 31 variables to map potential manufacturing competitive priorities; four competitive priorities were identified: cost, quality, flexibility and scope flexibility**
Production focus	Silveira and Sousa (2010)*	e.g. production (process type, automatization), investment and cost (work-in-process inventory, finished goods inventory, structure of production costs), infrastructure (supervisors' responsibility)
Performance indicators	**Jayaram et al. (1999)**	**cost reduction, quality improvement, time reduction**
Other, e.g. competitive priorities and performance indicators	Demeter (2003)*	e.g. selling price vs. average unit production cost, order size flexibility vs. changeover time

Studies dealing with the relationship between Operations Management and HRM printed in bold type; *use the IMSS questionnaire

My thesis builds upon the classic manufacturing strategy framework (Miller and Roth 1994; Frohlich and Dixon 2001): manufacturing strategy goals are derived from competitive capabilities (Table 6.7, left-hand side column). As far as the taxonomy of manufacturing strategy is concerned, these two articles count as basic literature, e.g. Miller and Roth's paper is the most cited one. I was reinforced in my decision by Cagliano et al. (2005), whose examination of manufacturing strategy configurations lead to the conclusion that in spite of the highly diverse range of operationalizations, there is a correspondence between the configurations proposed in acknowledged pieces of the literature and the taxonomy of Roth and Miller (1994) – which has already been applied previously in Hungary by Demeter (2000).

The taxonomy is simple, and another great advantage is that it can be adapted to the IMSS survey. A correspondence can be established between the competitive priorities (order-winning criteria) in the IMSS questionnaire and the competitive capabilities of the taxonomy (see Frohlich and Dixon's (2001) work above) (Table 6.7, right-hand side column).

Table 6.7. Operationalization of manufacturing strategy goals

Competitive capabilities	Corresponding question in the IMSS questionnaire* (nr. of question)
Price	
Low price	(a) Lower selling prices
Quality	
Conformance Performance	(c) Superior conformance to customer specifications (b) Superior product design and quality
Time	
Delivery speed Reliability	(e) Faster deliveries (d) More dependable deliveries
Services	
After-sales services Extended distribution Advertising	(f) Superior customer service (after-sales and/or technical support) not contained not contained
Flexibility	
Planning flexibility Volume flexibility Wide product range	(h) Offer new products more frequently (j) Greater order size flexibility (g) Wider product range

Source: based on Miller and Roth (1994) and Frohlich and Dixon (2001)
*A4. Consider the importance of the following attributes to win orders from your major customers. Importance in the last three years: 1 – not important; 5 – very important

Drawing upon the taxonomy, categorical manufacturing strategies can be identified. Miller and Roth (1994) found three manufacturing strategies:

- **Caretakers**: price is the dominant factor. Time-related capabilities and conformance to customers' expectations are relatively important.
- **Marketeers:** they distinguish themselves by their wider product range and greater order size flexibility. Further points of emphasis are conformance to customers' expectations, accurate deliveries and superior product design and quality.

- **Innovators**: they excel in product design, and exhibit a number of similarities to Marketeers, e.g. the importance of quality. Out of the three groups, it is here that price has the least significant role.

According to Frohlich and Dixon (2001) the three manufacturing strategies are easily linked to the Porterian competitive strategies (Table 6.8).[38] This is highly relevant to my research given that I relied predominantly on considerations pertaining to the cost-leadership and differentiation strategies in formulating my research questions and hypotheses.

Table 6.8. The relationship between manufacturing strategy and competitive strategy

Manufacturing strategy	Main characteristics	Relation to Porterian competitive strategy
Caretakers	low price, time and customer expectations	cost-leadership
Marketeers	product variety, volume flexibility	differentiation
Innovators	product design	focus

Source: based on Frohlich and Dixon (2001)

As is always the case when adopting an existing concept, certain limitations need to be taken into account when using Miller and Roth's (1994) taxonomy, as well. Miller and Roth (1994) describe the North American environment as of the 1990 (and the authors allude to the influence of the industry, as well). With regard to the use of the original concept, Frohlich and Dixon (2001) bring attention to potential changes with time, and to the fact that the number of strategies might be larger/smaller in some regions – that is, my results may differ from the original categories (e.g. impact of the crisis, wide range of industries, European focus, changes in the operating environment). Which is the very reason why – as also underlined by the works cited – in addition to methodological considerations, interpretability also had a key role in the forming of the manufacturing strategy groups.

Another important limitation is that – even though it was mentioned in the Introduction – I make no attempt to link the levels of business and manufacturing

[38] The manufacturing strategy literature also features approaches that are fundamentally different: the operationalization of the generic Porterian strategies, for instance (e.g. Kotha and Orne (1989) propose process, product and organizational attributes).

strategies (see e.g. Schroeder, Anderson, and Cleveland 1986; Ward and Duray 2000), as the exploration of the said relationship falls far beyond the scope of my dissertation.

6.2.5. Other Factors, Control Variables

The present study uses four control variables: size, type of process/customer orders and technology (Table 6.9).

Size is operationalized through the number of employees of the business unit. Numerous considerations suggest (Cua, McKone, and Schroeder 2001; Forza 1996; Shah and Ward 2003) that firms with more than 100 employees are more likely to implement lean production. Accordingly, **only those manufacturing firms** will be considered in the empirical analysis **that employ more than 100 people**.

In the course of my literature review, I have already hinted that process type might have an impact on the lean system. Question B8 addresses the process type: respondents were to divide 100% among one of a kind production, batch production and mass production. The variable was re-coded to a Dummy variable. A manufacturing firm was considered to be a *mass producer (Dummy variable=1) if batch production and mass production accounted for at least 50% of its processes.* Such a high proportion implies that the firm's process organization is dominated by the features of mass production rather than one of a kind production.

Table 6.9. Control variables

Other variables	Corresponding question in the IMSS questionnaire (nr. of question)
Size	(A1) What are the name, origin and size of the corporation of which your business unit is a part? (c) Size of the business unit **(number of employees)**: ____________
Process	(B8) To what extent do you use the following **process types** (% of volume)? One of a kind production Batch production Mass production Total (a)_________ % (b)_________ % (c)_________ % 100 % (B9) What proportion of your customer orders are Designed/engineered to order_Manufactured to order_Assembled to order_Produced to stock_Total (a)__________ % (b)_________ % (c)_________% (d)_________ % 100 %
Technology	(T1a) How advanced is the core process **technology** of your dominant activity? Mostly manual operations, using hand tools and/or manually operated general purpose machine tools and handling/transportation equipment 1 2 3 4 5 Most operations are done by highly automated machine tools and handling/transportation equipment (computer-controlled machines, robots, automated guided vehicles)

Note: the expression hereinafter used to refer to the given question (variable) is **underlined and printed in bold type**; Question B9 Type of customer orders

Question B9, addressing the type of customer orders (on a spectrum from design-to-order to production-to-stock), is also related to process organization. Once again, I introduced a Dummy variable. *Production is more mass-oriented (Dummy variable=1) at manufacturers where assembly-to-order (e.g. supermarket in a lean system) and production-to-stock together account for at least 50%. The remaining firms, where design-to-order and manufacturing-to-order have the greater share, tend to be driven by unique customer needs (Dummy variable=0).*

Previously, I emphasized the significance of continuous flow processes and technology with respect to lean management. Firms employing continuous processing are not part of the questionnaire's target group. The impact of technology can be operationalized through the answers provided to Question T1a.

6.3. Data Cleaning

As a preliminary to the analyses, the existing database needs to be examined and cleaned. Appendix 2 (Data Cleaning) presents the steps of the process broken down by variable group, and also shows, wherever possible, the observational units that were omitted. The cleaning of the database comprised the following phases:

1. *Entry accuracy*: Could be evaluated only for the items that were measured on a 5-point Likert scale (e.g. the value of 6 should not occur) or in percentages (e.g. sum total should not substantially differ from 100%). The entry accuracy of any other type of measurement (e.g. absolute number) was impossible to assess. The data were found to have been entered accurately. The only inaccuracy of any significance we identified was that the Dummy variable pertaining to the different types of incentives showed *missing value/1* pairs instead of *0/1* pairs. In the case of this variable, any missing values were assumed to be 0.
2. *Missing values*: The proportion of missing data was evaluated for each variable. Tsikriktsis (2005) proposes a rather liberal range with respect to the tolerability of missing values: he is willing to accept 5 or 10%, or sometimes even proportions in excess of 15%. Matyusz (2012) suggested that 15% be considered the upper limit, and I concur with his view. Three of the variables were missing values in excess of

that proportion: (1) proportion (O4a) and type of incentives (O4b1, O4b2, O4b3), (2) proportion of those working in cross-functional teams (O6b), and (3) percentage of annual sales spent on training (A6c). These variables were omitted from the analyses. One of the reasons why opting for the relatively high limit of 15% was practical was that it enabled several key variables to remain in the sample in spite of their 10-12% missing value ratios.

3. *Outliers:* The boxplot revealed outliers for three variables: (1) 9 or more organizational levels (Question O1); (2) values above 80 hours of training per employee (Question O7); and (3) organizations with more than 2000 employees (Question Ac1). The observational units producing these outlying values were omitted. Conceptual considerations led me to also omit the observational units where the number of employees was below 100. The variables with missing data (see the previous point) were not evaluated for outliers.
4. *Analysis of missing data by Little's MCAR test*: In view of the above (points 2 and 3), outliers were filtered out using an 'if' condition and the test was performed for each group of variables (lean technique, HRM, operational indicators, strategic goal). For all four groups, the test indicated that the data were missing at random. In this phase, the tests only yielded approximate results due to the filtering algorithm of the 'if' condition. When filtering for outliers, for instance, the observational units that were only missing data were omitted, as well. The test was not run for the control variables, for they cannot be reasonably assumed to constitute a variable group.
5. *Examination of observational units*: Data quality was assessed for each variable group at each respondent. Even though I kept to the 15% limit with the variables themselves, I was a bit more liberal here so as to keep as many observations as possible. An observation was removed if

   a. at least two out of the four questions associated with the 'lean production technique' variable group were left unanswered,

   b. at least three out of the nine questions associated with the 'human resource management' variable group were left unanswered,

   c. at least three out of the ten questions associated with the 'operational performance indicators' variable group were left unanswered,

d. at least three out of the nine questions associated with the ’manufacturing strategy goal’ variable group were left unanswered.

The control variables (except for the number of employees) were checked only after having replaced the missing values in all the other variable groups.

6. *Cleaning the data and using the EM algorithm to replace missing values*: Observations with outliers or responses of insufficient quality were removed, which reduced the sample size from 725 to 409.

   In the reduced database, the proportion of missing values was typically between 0.2-2%, and for no variable did it reach 10%. Concerning operational performance indicators, Little’s MCAR test showed that the data were missing not at random (sig.=0.031). Still, in consideration of the fact that the proportion of missing data did not even amount to 1% for most of the variables affected, I did include this variable group in the analyses.

   Missing values were imputed using the EM algorithm (with normal settings, run separately for each variable group).

7. *Analysis of control variables*: I removed the observational units that were missing data. This step was left until the very end in order to have a somewhat larger database to work with when imputing the missing values in Step 6. The results of the tests were not influenced by this step.

The main attributes of the final sample of 397 business units are presented in Table 6.10.

About 55% of the initial 725 observations remained in the final sample. For several countries, e.g. South Korea, United Kingdom, Estonia, Ireland, Japan and Mexico, the sample size reduced to one third of its initial value. As regards industries, it was the manufacture of other transport equipment and that of instruments the shares of which sunk most significantly. Because of the small sample size, no country or industry was omitted. As a last step, I tested each variable for normality on the final sample of 397 business units (Table 6.11), which was a prerequisite for my later analyses.

According to the Kolmogorov-Smirnov and Shapiro-Wilk tests performed for this purpose, none of the variables are normally distributed. This might be the consequence of the relatively large sample size (see Sajtos and Mitev, 2007) and/or the ambition to involve well-performing organizations in the survey. Therefore I took a different approach to normality testing: I evaluated the shape – the skewness and kurtosis, in particular – of the histograms. Then I transformed those variables for which both indices (skewness and kurtosis, that is) took absolute values above 1 (see e.g. Matyusz 2012).

Table 6.10. The fifth round of IMSS: sample characteristics (countries and industries)

	Country	# of plants (original sample)	% (original sample)
1.	United States of America	26 (48)	6.5 (6.6)
2.	Belgium	23 (36)	5.8 (5.0)
3.	Brazil	21 (37)	5.3 (5.1)
4.	Denmark	14 (18)	3.5 (2.5)
5.	South Korea	7 (41)	1.8 (5.7)
6.	United Kingdom	8 (30)	2 (4.1)
7.	Estonia	9 (27)	2.3 (3.7)
8.	Holland	28 (51)	7.1 (7.0)
9.	Ireland	2 (6)	0.5 (0.8)
10.	Japan	10 (28)	2.5 (3.9)
11.	Canada	16 (19)	4 (2.6)
12.	China	26 (59)	6.5 (8.1)
13.	Hungary	52 (71)	13.1 (9.8)
14.	Mexico	5 (17)	1.3 (2.3)
15.	Germany	24 (38)	6 (5.2)
16.	Italy	39 (56)	9.8 (7.7)
17.	Portugal	7 (10)	1.8 (1.4)
18.	Romania	15 (31)	3.8 (4.3)
19.	Spain	29 (40)	7.3 (5.5)
20.	Switzerland	21 (31)	5.3 (4.3)
21.	Taiwan	15 (31)	3.8 (4.3)
Total		**397 (725)**	**100**

Manufacturing activity (ISIC)	# of plants (# and proportion in original sample)
Manufacture of fabricated metal products (28)	138 (242, 57%)
Manufacture of machinery and equipment (29)	111 (185, 60%)
Manufacturing of office, accounting and computing machinery (30)	6 (12, 50%)
Manufacture of electrical apparatus and machinery n.e.c. (31)	60 (92, 65%)
Manufacture of radio, television and communication equipment and apparatus (32)	18 (42, 43%)
Manufacture of medical, precision and optical instruments, watches and clocks (33)	17 (42, 41%)
Manufacture of motor vehicles, trailers and semi-trailers (52)	29 (52, 54%)
Manufacture of other transport equipment (35)	13 (34, 30%)
Missing data	0 (24)
Total	**397 (725)**

I followed the recommendations of Sajtos and Mitev (2007) and thus, given the positive skewness of training and size, used the logarithmic transformation. The log-transformed training variable (N=389, for there was no training at eight units) already showed appropriate levels of skewness (-0.710) and kurtosis (0.856), and so did the size variable following the log-transformation (skewness=0.625; kurtosis=-0.508).

Table 6.11. Evaluating the normality of the individual variables

Variable	Mean	Std. dev.	Skewness	Kurtosis	Komogorov-Smirnov	Shapiro-Wilk	Tran.
Lean production techniques							
Process focus	3.42	0.056	-0.356 (0.122)	-0.656 (0.244)	0.215 (0.000)	0.903 (0.000)	
Pull production	3.18	0.059	-0.149	-0.851	0.175 (0.000)	0.914 (0.000)	
Quality improvement	3.17	0.055	-0.186	-0.700	0.192 (0.000)	0.913 (0.000)	
TPM program	3.00	0.055	-0.164	-0.698	0.180 (0.000)	0.911 (0.000)	
Human Resource Management Practices							
Organizational levels	3.80	0.056	0.594	1.395	0.200 (0.000)	0.910 (0.000)	
Involved in process improvement	3.25	0.052	-0.085	-0.651	0.180 (0.000)	0.912 (0.000)	
Continuous improvement	3.37	0.063	-0.317	-0.923	0.191 (0.000)	0.900 (0.000)	
Functional teams	57.26	1.602	-0.293	-1.164	0.135 (0.000)	0.926 (0.000)	
Training	**23.73**	**0.900**	**1.412**	**2.777**	**0.162 (0.000)**	**0.888 (0.000)**	**log.**
Multi-skilled workers	46.43	1.384	0.244	-1.133	0.135 (0.000)	0.944 (0.000)	
Rotation	3.06	0.048	0.338	-0.601	0.215 (0.000)	0.884 (0.000)	
Autonomy	3.03	0.048	-0.003	-0.414	0.199 (0.000)	0.904 (0.000)	
Delegation	3.04	0.053	0.009	-0.687	0.169 (0.000)	0.912 (0.000)	
Manufacturing Strategy Goals							
Lower selling prices	3.87	0.051	-0.709	-0.105	0.235 (0.000)	0.858 (0.000)	
Offer new products more frequently	2.98	0.055	-0.047	-0.694	0.161 (0.000)	0.919 (0.000)	
Greater order size flexibility	3.29	0.059	-0.375	-0.678	0.203 (0.000)	0.907 (0.000)	
Wider product range	3.25	0.054	-0.170	-0.649	0.184 (0.000)	0.915 (0.000)	
Superior conformance to customer specifications	4.09	0.044	-0.728	0.030	0.225 (0.000)	0.832 (0.000)	
Superior product design and quality	4.17	0.043	-0.0983	0.804	0.237 (0.000)	0.810 (0.000)	
Faster deliveries	3.76	0.050	-0.606	-0.117	0.242 (0.000)	0.876 (0.000)	
More dependable deliveries	4.03	0.044	-0.762	0.432	0.242 (0.000)	0.843 (0.000)	
Superior customer service (after-sales and/or technical support)	3.77	0.053	-0.684	-0.015	0.223 (0.000)	0.874 (0.000)	
Operational Performance Indicators							
Manufacturing conformance	3.17	0.044	0.218	-0.101	0.257 (0.000)	0.885 (0.000)	
Product quality and reliability	3.18	0.045	0.274	-0.465	0.247 (0.000)	0.881 (0.000)	
Volume flexibility	3.37	0.048	-0.045	-0.654	0.199 (0.000)	0.897 (0.000)	
Mix flexibility	3.26	0.049	0.190	-0.835	0.208 (0.000)	0.889 (0.000)	
Unit manufacturing cost	2.86	0.046	0.399	0.050	0.238 (0.000)	0.881 (0.000)	
Delivery speed	3.18	0.047	0.167	-0.474	0.226 (0.000)	0.896 (0.000)	
Delivery reliability	3.20	0.049	0.163	-0.686	0.210 (0.000)	0.895 (0.000)	
Manufacturing lead time	3.01	0.044	0.457	-0.322	0.244 (0.000)	0.866 (0.000)	
Inventory turnover	2.87	0.046	0.335	-0.369	0.206 (0.000)	0.886 (0.000)	
Labor productivity	3.05	0.044	0.417	-0.229	0.249 (0.000)	0.873 (0.000)	
Control							
Size	**449.91**	**220.72**	**1.928**	**3.125**	**0.220 (0.000)**	**0.730 (0.000)**	**log.**

Notes: Tran: transformation, log.: logarithmic

6.4. Determining the Units of Analysis

6.4.1. Defining Manufacturing Strategy Goals

The identification of the content of manufacturing strategy goals is the subject of Research Question 1: **How should the cost-leader and differentiator manufacturing strategy goals be interpreted in the end of the 2000s, based on our sample of manufacturing firms?**

According to the methodological recommendations of Miller and Roth (1994), one needs to concentrate on two aspects when defining manufacturing strategy groups: (a) is there a difference between the groups' cluster means with respect to the competitive priority in question, (b) what are the relative priorities of the competitive priorities within a given group. Sometimes the relative importance of a priority may carry more weight than its mean (absolute value). One should use the trial-and-error method, with due consideration to interpretability, to decide about the number of manufacturing strategies. Some of the earlier studies did not find 3, but only 2 or as many as 4 or 5 manufacturing strategies.

I used hierarchical clustering (Ward's method, Euclidean distance) to identify manufacturing strategy goals. The coefficients in the agglomeration schedule and the dendrogram suggest that two clusters should be formed (Table 6.12 and Figure 6.2). For the ease of interpretation, the means (the higher value underlined and printed in bold type) and their differences (was significant in each case) are compared for each variable, and the order of importance of the variables is also given for each cluster (in parentheses).

The results indicate the existence of two markedly different manufacturing strategy goals. The firms in Cluster 1 attribute greater significance to all but one of the competitive capabilities – cost being the exception – than those in Cluster 2. As Figure 6.2 and the rightmost column of Table 6.12 evince, there is a remarkable gap between the two clusters in terms of flexibility, speed and customer service.

Even though the two clusters differ significantly with respect to all the variables, the differences are somewhat smaller for quality and dependability. The variables' order of importance is different for the two clusters, as well: as regards Cluster 2, emphasis is on cost and quality; while the members of Cluster 1 prioritize quality and time.

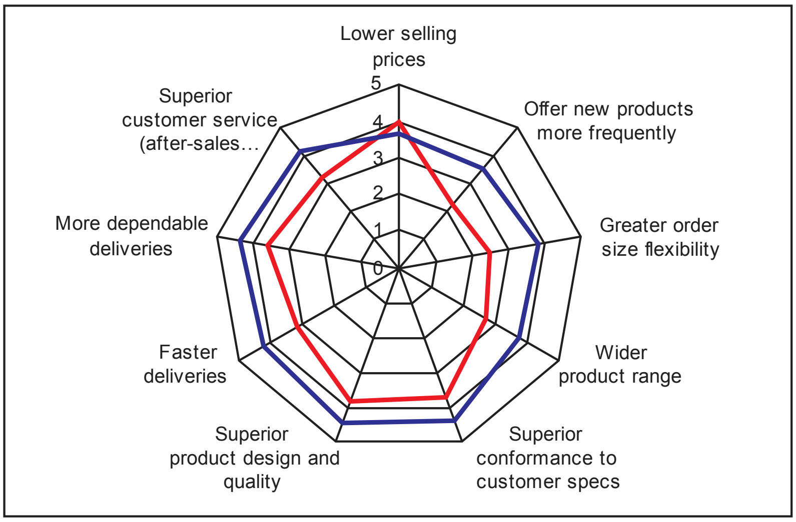
By comparing the absolute and relative importance of the priorities, I managed to identify the cost-leadership and differentiation strategies. These strategies of mine are – applying Frohlich and Dixon's (2001) approach – closely related to the cost-leadership and the differentiation strategies, on account of the importance they attach to price, and to quality and flexibility, respectively.

Table 6.12. Manufacturing strategies – two-cluster solution

Competitive capability	**Manufacturing strategy**		Quality and flexibility	Cost	**Difference**
			Cluster 1	Cluster 2	
	Variable	**# of units**	**224**	**173**	
Price	Lower selling prices		3.78 (7)	**3.99** (1)*	-0.21
Flexibility	Offer new products more frequently		**3.53** (9)	2.27 (9)	1.26
	Greater order size flexibility		**3.85** (6)	2.57 (8)	1.28
	Wider product range		**3.70** (8)	2.68 (7)	1.02
Quality	Superior conformance to customer specifications		**4.40** (2)	3.70 (3)	0.70
	Superior product design and quality		**4.46** (1)	3.79 (2)	0.67
Time	Faster deliveries		**4.24** (4)	3.14 (6)	1.10
	More dependable deliveries		**4.36** (3)	3.59 (4)	0.77
Services	Superior customer service (after-sales and/or technical support)		**4.22** (5)	3.17 (5)	1.05
# of lean companies			158	112	
# of non-lean companies			66	61	
Remark			No significant relationship between lean and manufacturing strategy. (Pearson's Chi-squared =1.507, 2-sided 0.234)		

Notes: **the highest value** and (relative importance in the given cluster)
The difference is significant in each case (at the 0.000 level), * significant at the 0.045 level

Figure 6.2. Manufacturing strategies – Two clusters



Notes: Cluster 1 (quality and flexibility) blue line, Cluster 2 (cost-oriented) red line

Thus Research Question 1 can be answered as follows:

- As for the **cost-leadership manufacturing strategy (Cluster 2), costs are the top priority.** This cluster will be referred to hereinafter as the **cost-oriented manufacturing strategy**.
- The firms in Cluster 1 put emphasis on quality and, in addition, rely on flexibility in its broad sense (variety, development, order size flexibility and speed, as a time-related dimension of flexibility). Accordingly, the **differentiation strategy is interpreted as a quality- and flexibility-oriented manufacturing strategy**.

There are significant differences between the two strategies – an indication of which is that the quality- and flexibility-oriented group attributes above-average importance (score above 3) to each item. The difference between the most („Superior product design and quality", 4.46) and the least („Offer new products more frequently", 3.53) prioritized criteria is less than 1. The above-average scores and the small differences between them both suggest that this group of firms operate under strong pressure from their customers: their clients expect improvements in all areas. (The values might possibly also imply that production managers do not grasp what is expected of them.) The cost-oriented group features a number of scores below the average, and the difference between the two extremes (the criteria „Lower selling prices" (3.99) and „Offer new products more frequently" (2.27)) is much larger, too. This group's top priority is easier to point a finger at, and the stress that customers put on production managers is probably a trifle lighter.

The validity of the two-cluster solution can be confirmed methodologically, and corroborated from both an interpretability and an international perspective. Moreover, the resulting sample is of a size that allows for the planned analyses (Cluster 1 contains 158 observational units, while Cluster 2 consists of 112).

Based on our sample of manufacturing firms from the late 2000s, only two manufacturing strategies can be defined. My results can nevertheless be compared to the classic three-cluster solution. My cost-leadership strategy may be equated to the 'Caretakers' category of Miller and Roth; price is the top priority for both. My quality- and flexibility-oriented manufacturing strategy is a blend of Miller and Roth's Marketeers (time, quality, flexibility) and Innovators (time, quality, new products). It does, however, differ from both insofar as variety and speed have substantially gained in relative importance (6th place now instead of the original 10th, and 4th instead of 6th/7th, respectively) and, at the same time, Innovators' stellar score for new product launches was not reproduced here (though the score is still quite high as compared to the other group). While the interpretation of the cost-leadership strategy appears stable, the contents of the differentiator and focus strategies have undergone significant changes.

The answers provided to Research Question 1 allow Research Questions 2 and 3 to be refined and re-phrased as hypotheses:

Research Question 2: How do manufacturing strategy goals influence the presence and intensity of use of HPWS practices in a lean environment?

Expectation: Lean producers with a differentiation strategy make more intensive use of HPWS practices than those with a cost-leadership strategy.

Hypothesis 1: Quality- and flexibility-oriented lean producers make more intensive use of HPWS practices than cost-oriented lean producers do.

Research Question 3: How do manufacturing strategy goals affect the contribution of HPWS practices to operational performance in a lean environment?

Expectation: Lean producers with a differentiation strategy are more efficient in using HPWS practices than those with a cost-leadership strategy.

Hypothesis 2: Quality- and flexibility-oriented lean producers are more efficient in using HPWS practices than cost-oriented lean producers are.

6.4.2. Defining Lean Producers

Lean manufacturers are distinguished based on their use of lean production techniques.

The correlation between the variables is significant at the 0.01 level. The correlation is weak, except between 'Quality improvement' and 'TPM program' (Pearson correlation coefficient: 0.616). I decided that the strength of the relationship would permit the use of cluster analysis.

Using hierarchical clustering (Ward's method, Euclidean distance), the coefficients in the agglomeration schedule and the dendrogram suggest that either two or three clusters should be formed. I examined the two- and three-cluster solutions by k-means clustering. The two- and the three-cluster solutions identified 127 and 116 non-lean firms, respectively. The two sets of non-lean producers overlapped to a rather high degree: out of the 116 firms of the three-cluster solution, 115 were identified as non-lean by the two-cluster solution, as well. The near identity of the two results means that the group of firms lagging behind in / not striving for the implementation of the lean system is homogeneous. It was after having established this that I decided for the two-cluster solution, for it was just as efficient in highlighting the firms that were ahead in terms of lean implementation as the three-cluster solution, yet yielded groups that were easier to interpret. Another practical advantage is that the resulting groups are larger and easier to perform my further analyses on (Table 6.13).

Table 6.13. Identification of lean manufacturers by means of lean production techniques

Variable	Lean (N=270)	Non-lean (N=127)	ANOVA	Mean
Process focus	3.85	2.50	F=182.093 Sig.=.000	3.42
Pull production	3.63	2.24	F=166.724 Sig.=.000	3.18
Quality improvement	3.67	2.21	F=295.489 Sig.=.000	3.17
TPM program	3.41	2.13	F=166.719 Sig.=.000	3.00

Considering lean production techniques, the two clusters exhibit the following differences: the lean cluster contains the firms for which the sum total of the responses to the four practices is at least 12 (out of the possible maximum of 20), while the non-lean cluster comprises those for which the said sum does not exceed 11. The four variables were combined into a new one (Cronbach's alpha 0.701). The 'Lean Technical Subsystem' variable is the unweighted arithmetic mean of the standardized values of the four variables.

Out of the technical elements of lean, process focus is the one most widely present among the 270 lean manufacturers. Pull production and quality improvement „tied" for second place. TPM programs exhibited the least marked presence. Our hypotheses will be tested on this subsample of firms.

Regarding the 127 non-lean producers, the technical elements of lean follow each other in a similar order. These firms also put some (though considerably less) effort into implementing the lean system (values between 2.0-2.5).

I follow the common interpretation of the questionnaire's variables in distinguishing lean and non-lean producers: viz. regard those firms as lean producers that put significant effort into adapting lean production techniques during the last three years. Due to the phrasing of some of the questionnaire's questions, it might happen that one or two firms that do make extensive use of lean production techniques report that exactly during those last couple of years they did not pay that much attention to the lean system, for they had already had it in place. Yet experience from practice rather suggests that firms that are truly committed to the lean system tend to keep – in line with the continuous improvement principle – technical practices on the agenda. That is, the extent of the efforts exerted in connection with lean practices is very likely to indeed represent a good approximation of the firm's lean maturity.

6.4.3. Classification of Human Resource Management Practices

The literature offers several methods for classifying Human Resource Management practices: principal component analysis or indexing (see. e.g. MacDuffie, 1995). The present thesis employs principal component analysis for identifying the underlying structure of Human Resource Management practices.

Given that we will return to this methodology several times later on, I provide a brief overview of the procedure (based on Sajtos and Mitev (2007), and Székelyi and Barna (2003)). It is a data reduction technique for identifying latent dimensions beyond certain variables. The variables' attributes (Likert scale, ratio, normal distribution) and the sample size (at least 5 or 10 times the number of variables) enable me to use this method here. As for the variable groups that featured different measurement scales (e.g. HRM practices), I worked with the variables' standardized values. In determining the number of latent dimensions I relied on the Scree Plot („elbow-rule"), the Kaiser-Meyer-Olkin measure (at least 0.5) and Bartlett's test (significant relationship, the null hypothesis being that there is no correlation between the initial variables). In order to double-check the relationship between the variables, I also looked at the MSA value of the anti-image correlation matrix (at least 0.5). The factors (a principal component) were (was) accepted if they (it) preserved at least one third (half) of the total information content. The relevant recommendations suggest that a variable should not be considered an element of the factor (principal component) unless its communality is at least 0.25. For factor loadings, the recommended limit is 0.5. As my intention was to later involve the factors in regression calculations, I opted for an orthogonal rotation algorithm. In certain cases, researchers need to decide themselves which factor a variable belongs to: a variable can be said to unambiguously belong to only one factor if (1) only one of its factor loadings exceeds 0.25, or if (2) the absolute value of one of its factor loadings is larger than two times any one of its other factors loadings. Should an unambiguous assignment be impossible, the variable must be omitted. Based on the results of the factor analysis, I created new variables. With respect to the variables in the same factor, the subsequent analyses use the unweighted arithmetic mean of the original variables.

The respondents of the questionnaire evaluated HRM practices on Likert scales and ratio scales. The data reduction procedure was performed on the entire sample of 397 units. The normality testing, as well as the required transformations have already been performed earlier. The variables 'organizational levels' (slightly leptokurtic), 'functional teams' and 'multi-skilled workers' (slightly platykurtic) were not transformed, as the absolute values considered critical remained below 2 (IBM, SPSS manual). Sample size is acceptable (for 9 variables).

According to the „elbow-rule', the Scree Plot yielded four latent variables. The eigenvalue of the fourth factor was, however, already smaller than 1. I opted for three factors, which altogether explained 55.223% of the variance. The MSA values of the anti-image correlation matrix were between 0.466 and 0.771. The 0.466 value, somewhat below the threshold of 0.5, belonged to 'functional teams' – yet owing to its critical importance, the variable was not omitted. Each variable showed a communality above the expected 0.25 level (between 0.391-0.627). The value of the Kaiser-Meyer-Olkin measure (0.715) suggested that the variables are suitable for the analysis, and so did Bartlett's test (Approx. Chi-square=486.534, df=36, Sig.=.000). The orthogonal rotation (varimax) was used.

In the rotated matrix, 'organizational levels' had a factor loading of 0.454, and thus the variable was removed.

According to the value of the Kaiser-Meyer-Olkin measure computed for this new set of variables (0.721), they were suitable for the analyses, and Bartlett's test (Approx. Chi-square=462.516, df=28, Sig.=.000) also indicated that the correlation between the variables was high. Once again, the orthogonal (varimax) rotation was used. As regards communality, 'autonomy' scored the lowest at 0.413. The three factors explained 60.238% of the variance. In this run, 'autonomy' achieved the lowest factor loading (0.521 for the third factor); as a matter of fact, it loaded on two factors: the third (0.521) and the first (0.329). The difference between the two factor loadings being smaller than desirable, the variable was removed.

As regards HRM practices, 7 variables remained for further analyses. The Kaiser-Meyer-Olkin measure (0.707) and Bartlett's test (Approx. Chi-square=402.923, df=21, Sig.=.000) were both appropriate. Again, the orthogonal rotation (varimax) was used. Communality values were scattered between 0.571 and 0.929. The three factors explain 65.989% of the variance. The analysis combined the variables into the following three factors:

- quality-related practices, decentralization and training belong to the **Involvement and Development** factor
- multi-skilled workers and rotation to the **Employee** factor, and
- the 'functional teams' variable to the **Teamwork** factor.

Table 6.14. Results of the factor analysis – HRM practices

Latent variable	HRM practices	Variable in the IMSS questionnaire	1	2	3
Involvement and development	Quality-related practices	Involvement in process improvement	0.720		
		Continuous improvement	0.748		
	Decentralization	Delegation	0.699		
	Training	Training	0.699		
Employee	Job	Multi-skilled workers		0.844	
		Rotation		0.843	
Teamwork	Teamwork	Functional teams			0.961

New variables were created, defined as the unweighted arithmetic mean of the standardized values of the variable(s) assigned to the individual factors. The mean was substituted for the values that the ’training’ variable was missing (four lean producers reported training as 0 hours/employee, which the logarithmization process could not handle (firms affected: BR27, IT7, RO2, RO5)).

HRM practices being the focus topic of the dissertation, a more detailed evaluation of the variables to be used in the final round of analyses is essential. The final set of HRM variables (factors) will be evaluated against two frames of reference: they will be positioned in relation to both the literature reviewed herein and the classic study by MacDuffie (1995).

Much like the majority of the studies I reviewed, my work is also limited to investigating only a handful of HRM practices. My research **involves about one half of the totality of HRM variables found in the papers reviewed** (Table 6.15).

Using MacDuffie’s (1995) paper as a frame of reference also allows for a qualitative evaluation (in addition to the quantitative comparison above) of my study’s HRM variables. MacDuffie distinguishes between two groups of practices in HRM: work organization (practices related to the performance of daily tasks) and HRM policies (the HRM framework). The pairing presented in Table 6.16 (to be considered an approximation at best) shows that the HRM practices involved in my research can be associated with MacDuffie’s work organization bundle. The only exception is ’training’, which however the factor analysis unequivocally linked to work organization in our case.

Table 6.15. Evaluation of HRM practices (factors) against the literature review

HRM practices important to the lean system	Socio-technical lean papers	My research
Decentralization (involvement, autonomy)	X	X
Quality (quality circles, employee suggestion system)	X	X
Job enhancement, rotation, job enlargement (e.g. maintenance, ordering, SPC)	X	X
Training (e.g. skills, problem solving)	X	X
Recruitment	X	-
Teamwork	X	X
Communication (feedback, quality feedback)	X	-
Hierarchy	X	-
Compensation (knowledge-based, performance evaluation, both individual- and team-level)	X	-
Reciprocity	-	-

Table 6.16. Evaluation of HRM practices (factors) against MacDuffie's (1995) bundles

MacDuffie (1995)	Variable of the IMSS questionnaire
Work organization (Work System Index)	
Work teams	**Functional teams**
Problem-solving groups (employee involvement, quality circles)	**Employee involvement in process development**
Employee suggestions made and implemented	**Continuous improvement**
Rotation	**Rotation**
	Multi-skilled workers
Decentralization of quality-related tasks	**Autonomy**
	Delegation
Generic HR policies (HRM Policies Index)	
Recruitment and hiring	no relevant question in the questionnaire
Contingent compensation	variable had to be omitted from the analysis
Status differentiation	proxy variable (# of organizational levels) had to be omitted from the analysis
Training of new employees	no relevant question in the questionnaire
Training of experienced employees	**Training**

The HRM variables involved in my research correspond to the HRM variables used in the socio-technical literature on lean management. Even though my research only covers a limited subset of the lean system's HRM practices, the number of HRM variables involved is in line with what appears usual for similar studies. MacDuffie's work organization bundle is entirely covered by my HRM variables.

6.4.4. Classification of Operational Performance Indicators

Operational performance indicators were classified using principal component analysis (Table 6.17).

Respondents evaluated the variables on Likert scales. None of the variables differed from the normal distribution. The sample size was appropriate (for 10 variables). The „elbow-rule" revealed one latent variable on the Scree Plot. All the variables could be involved, as the MSA values of the anti-image correlation matrix were between .833 and .939 (above 0.5) and all the communality values exceeded the threshold of 0.25, as well. According to the value of the Kaiser-Meyer-Olkin measure (0.878), the variables were suitable for the analyses, and Bartlett's test (Approx. Chi-square=1762.804, df=45, Sig.=0.000) also indicated that the correlation between the variables was high. The orthogonal rotation (varimax) was used.

The principal component analysis with Varimax rotation performed on the ten performance indicators yielded one principal component. (Thus in fact there was no rotation.) This factor explained 49.336% of the variance. The performance indicator was generated using the combined scale method: by taking the mean of the variables.

Table 6.17. Operationalization of operational performance indicators in the IMSS questionnaire

Operational performance indicators (variables of the IMSS questionnaire)	Factor loadings	Communality
Delivery speed	0.769	0.591
Delivery reliability	0.754	0.568
Labor productivity	0.738	0.544
Manufacturing lead time	0.716	0.513
Product quality and reliability	0.710	0.505
Mix flexibility	0.706	0.498
Manufacturing conformance	0.680	0.462
Volume flexibility	0.666	0.444
Unit manufacturing cost	0.637	0.406
Inventory turnover	0.634	0.402

The operational performance indicators of the lean and non-lean producers were compared. Lean producers performed significantly better (achieved larger performance improvements in the past period) than non-lean producers with respect to all the indicators in question. Lean manufacturing firms averaged above 3 in all items, which translates into improvements of at least 5-15%. A couple of exceptions apart, non-lean manufacturers averaged below 3, which implies stagnating performance indicators, or 5-15% improvements at most. The operational performance indicators were combined into a single variable. The ’Operational Performance Indicator’ index is the unweighted arithmetic mean of the variables’ standardized values.

7. Analysis

The present section of the thesis comprises three subchapters.

Subchapter 7.1 provides a brief overview of lean producers and the different manufacturing strategy goals they pursue. Having discussed the characteristics of lean manufacturers, we switch to hypothesis testing.

Subchapter 7.2 tests Hypothesis 1, which proposes that there is a difference in the intensity of use of HRM practices among lean producers by the manufacturing strategy goal they pursue. The ANOVA method is employed for this purpose.

Subchapter 7.3 tests Hypothesis 2, which proposes that the contribution of HRM practices to the operational performance of lean manufacturers differs by the manufacturing strategy goal pursued. Here we use regression analysis.

7.1. Characteristics of Lean Manufacturing Firms

Lean manufacturers will be discussed from three perspectives: (1) use of lean production techniques, (2) improvement in operational performance indicators and (3) differences in the control variables.

Lean production techniques. Lean producers that pursue different manufacturing strategy goals also exhibit significant differences in the use of numerous lean production techniques: quality- and flexibility-oriented lean manufacturers put more effort into each practice than cost-oriented ones do (Table 7.1).

In several cases, the difference is significant: at the 0.05 level for process focus and quality improvement, and at the 0.1 level for TPM programs. This distinction implies that **lean manufacturers' technical subsystems differ by the manufacturing strategy pursued**.

Table 7.1. Lean production practices at lean manufacturers – by manufacturing strategy goal

Variable	Quality- and flexibility-oriented (N=158)	Cost-oriented (N=112)	ANOVA	Mean
Process focus	**3.95**	**3.71**	**F=4.306 Sig.=0.039**	**3.85**
Pull production	3.68	3.55	F=0.983 Sig.=0.322	3.63
Quality improvement	**3.75**	**3.54**	**F=4.081 Sig.=0.044**	**3.67**
TPM program	*3.50*	*3.28*	*F=3.774 Sig.=0.053*	*3.41*
Sum total of the scores for lean production techniques (max. 20)	**14.88**	**14.08**	**F=9.960 Sig.=0.002**	**14.55**

Note: **significant at the p=0.05 level**, *significant at the p=0.1 level*

Improvement in operational performance indicators. The fact that the average scores for operational performance change are scattered around 3 indicates that lean manufacturers – both groups – report performance improvements of about 5-15% (Table 7.2). The differences in the individual indicators and some of the cost-oriented lean manufacturers' scores' averaging below 3 imply, nonetheless, that there are differences between the two groups.

Table 7.2. Improvement in operational performance indicators – by manufacturing strategy goal

Variable	Quality- and flexibility-oriented (N=158)	Cost-oriented (N=112)	ANOVA	Mean
Manufacturing conformance	3.41	3.25	F=2.355 Sig.=0.126	3.34
Product quality and reliability	3.41	3.27	F=1.631 Sig.=0.203	3.35
Volume flexibility	3.56	3.38	F=2.185 Sig.=0.141	3.49
Mix flexibility	**3.47**	**3.23**	**F=3.971 Sig.=0.047**	**3.37**
Unit manufacturing cost	*3.10*	*2.89*	*F=3.605 Sig.=0.059*	*3.01*
Delivery speed	**3.51**	**2.98**	**F=21.644 Sig.=0.000**	**3.29**
Delivery reliability	**3.49**	**3.08**	**F=11.696 Sig.=0.001**	**3.32**
Manufacturing lead time	3.20	3.02	F=2.544 Sig.=0.112	3.13
Inventory turnover	**3.13**	**2.85**	**F=5.540 Sig.=0.019**	**3.01**
Labor productivity	**3.32**	**3.04**	**F=6.669 Sig.=0.010**	**3.20**
Operational performance improvement index	**3.36**	**3.10**	**F=11.329 Sig.=0.001**	**3.25**

Note: **significant at the p=0.05 level**, *significant at the p=0.1 level*

Quality- and flexibility-oriented lean manufacturers had means of at least 3 for all indicators. Cost-oriented lean manufacturers' score remained below 3 in three cases: delivery speed (2.98), unit manufacturing cost (2.89) and inventory turnover (2.85). For 5 indicators, the difference between the two groups is significant: cost-oriented firms fall behind in terms of delivery speed (p=0.000), delivery reliability (p=0.001), labor productivity (p=0.010), inventory turnover (p=0.019), as well as mix flexibility (p=0.047). Add to this the unit manufacturing cost variable, which averages below 3 for them, and the difference in which is significant at the 0.1 level (p=0.059), and we can see that **cost-oriented lean manufacturers fall behind the other group in the majority of operational performance improvement indicators**.

The improvement observed in operational performance indicators is partly in line with customer expectations. The quality- and flexibility-oriented group – sensing customers' increasing expectations in all areas – succeeded in improving most of the relevant indicators. Cost-oriented firms had some success in that respect, too, but they consistently fall behind the other group with respect to the degree of such improvements. Lower selling prices being the most important criterion for the cost-oriented group, it came as something of a surprise that the quality- and flexibility-oriented group outperformed them in terms of cost reduction, as well.

Control variables. I examined the two nominal variables first. The analysis of the contingency table pertaining to the 'customer service process' Dummy (unique customer needs 0, „mass-like" needs 1) suggests the lack of a relationship between the customer service process and manufacturing strategy goals (Table 7.3). According to Pearson's Chi-squared test (1.009; df=1; p=0.315), Cramer's V and the contingency coefficient (0.61; p=0.315), a significant relation does indeed not exist.

Table 7.3. Relationship between the customer service process and manufacturing strategy goals (N)

Variable (Dummy)	Quality- and flexib.-oriented	Cost-oriented	Total
Unique customer needs (0)	92	72	164
„Mass-like" needs (1)	66	40	106
Total	158	112	270

Similarly, the contingency table pertaining to the 'mass-orientation of the production process' Dummy (non-mass producer 0, mass producer 1) indicates the absence of a relationship between mass-orientation and manufacturing strategy goals (Table 7.4). Nor do Pearson's Chi-squared test (1.102; df=1; p=0.294), Cramer's V or the contingency coefficient (0.640; p=0.294) indicate a significant relation.

Table 7.4. Relationship between the mass-orientation of the production process and manufacturing strategy goals (N)

Variable (Dummy)	Quality- and flexib.-oriented	Cost-oriented	Total
Non-mass producer (0)	35	19	54
Mass producer (1)	123	93	216
Total	158	112	270

Responses to size (logarithmized) and process technology were compared by the t-statistic. No difference was found between lean manufacturers according to manufacturing strategy goal (Table 7.5).

Table 7.5. Relationship between size and process technology vs. manufacturing strategy goals

Variable	Quality and flexibility-oriented (N=158)	Cost-oriented (N=112)	ANOVA	Mean
Size (log)	2.543	2.530	F=.100 Sig.=0.752	2.538
Technology	3.27	3.21	F=.228 Sig.=0.633	3.250

Quality- and flexibility-oriented lean manufacturers are more focused on using the technical practices of lean, and the improvement observed in their operational performance indicators is higher in degree. Therefore my further analyses will also involve an aggregated 'lean production techniques' variable (arithmetic mean of the individual technical practices' scores) as a control variable. **The two groups showed no differences in the control variables**: they are characterized by similar customer service processes, production processes (with respect to mass-orientation), technologies and employee headcounts.

7.2. Intensity of Use of Human Resource Management Practices

According to the assumption of Hypothesis 1, quality- and flexibility-oriented lean manufacturers make more intensive use of HRM practices than cost-oriented lean manufacturers do. Hence our expectation that quality- and flexibility-oriented lean manufacturers will score higher in HRM practices (except for the number of organizational levels). The nine HRM practices considered in the comparison and the results are shown in Table 7.6.

Contrary to our prior expectations, quality- and flexibility-oriented lean manufacturers do not use HPWS practices more intensely than their cost-oriented counterparts do. Because of the two groups' similar intensity of use of HRM practices, **Hypothesis 1 cannot be accepted.** Even if none of them is significant in extent, some minor differences do exist between the two groups:

- Concerning 'Hierarchy', cost-oriented lean manufacturers appear to have less organizational levels, yet the two values are very close. The direction of the difference is the opposite of what we expected.
- Quality- and flexibility-oriented lean manufacturers are ahead in terms of 'Quality improvement and involvement' practices. This is supported by the difference in continuous improvement being significant at the 0.1 level. The direction of the difference agrees with prior expectations.
- There is no difference as regards 'Teamwork', though cost-oriented firms reported higher proportions. The direction of the difference goes against our prior expectations.
- The two groups are similar with respect to 'Training', as well, even though the values that cost-oriented firms provided were, once again, higher. The direction of the difference contradicts our expectations.
- With regard to 'Job enhancement, rotation, job enlargement', the share of multiskilled workers is higher at cost-oriented firms, and they are the ones to rely more heavily on rotation, as well. There is a significant (at the 0.1 level) difference in the proportion of multiskilled workers between the quality- and flexibility-oriented (44.77) and the cost-oriented (50.63) clusters. The direction of the difference is the opposite of what we expected.

- The quality- and flexibility-oriented group scored higher, though not significantly, in autonomy and delegation (both elements of 'Decentralization'). The direction of the difference concurs with our prior expectations.

Table 7.6. The relationship between HRM practices (standardized values) and manufacturing strategy

HRM practices	Variable	Quality- and flexibility-oriented (N=158) (value acc. to orig. measurem.)	Cost-oriented (N=112) (value acc. to orig. meas.)	ANOVA	Mean
Hierarchy	Organizational levels	0.0636 (3.87)	**-0.0249 (3.77)**	F=0.528 Sig.=0.468	0.0269 (3.83)
Quality improvement, involvement	Involved in process development	**0.2462 (3.51)**	0.0807 (3.34)	F=1.979 Sig.=0.161	0.1776 (3.44)
	Continuous improvement	***0.4513 (3.94)***	*0.2673 (3.71)*	*F=3.275 Sig.=0.071*	*0.3749 (3.84)*
Teamwork	Functional teams	0.0019 (57.31)	**0.0710 (59.52)**	F=.336 Sig.=0.563	0.0304 (58.23)
Training	Training (log)	0.1378 (25.68)	**0.1473 (26.41)**	F=0.007 Sig.=0.935	0.1418 (25.99)
Job enhancement, rotation, job enlargement	*Multiskilled workers*	*-0.0601 (44.77)*	***0.1526 (50.63)***	*F=2.953 Sig.=0.087*	*0.0281 (47.20)*
	Rotation	0.0829 (3.14)	**0.1522 (3.21)**	F=.294 Sig.=0.588	0.1116 (3.17)
Decentralization	Autonomy	**0.0967 (3.12)**	-0.0103 (3.02)	F=0.765 Sig.=0.382	0.0523 (3.08)
	Delegation	**0.2590 (3.31)**	0.2387 (3.29)	F=0.030 Sig.=0.862	0.2506 (3.30)

Note: **the higher value**; *significant at the p=0.1 level*

Even though significant differences could not be detected, Table 7.6 and the items above seem to support that

- quality- and flexibility-oriented lean manufacturers put somewhat more emphasis on quality improvement and decentralization (as related to the former), and
- cost-oriented lean manufacturers attach more importance to rotation (as related to multiskilled workers), training and teamwork.

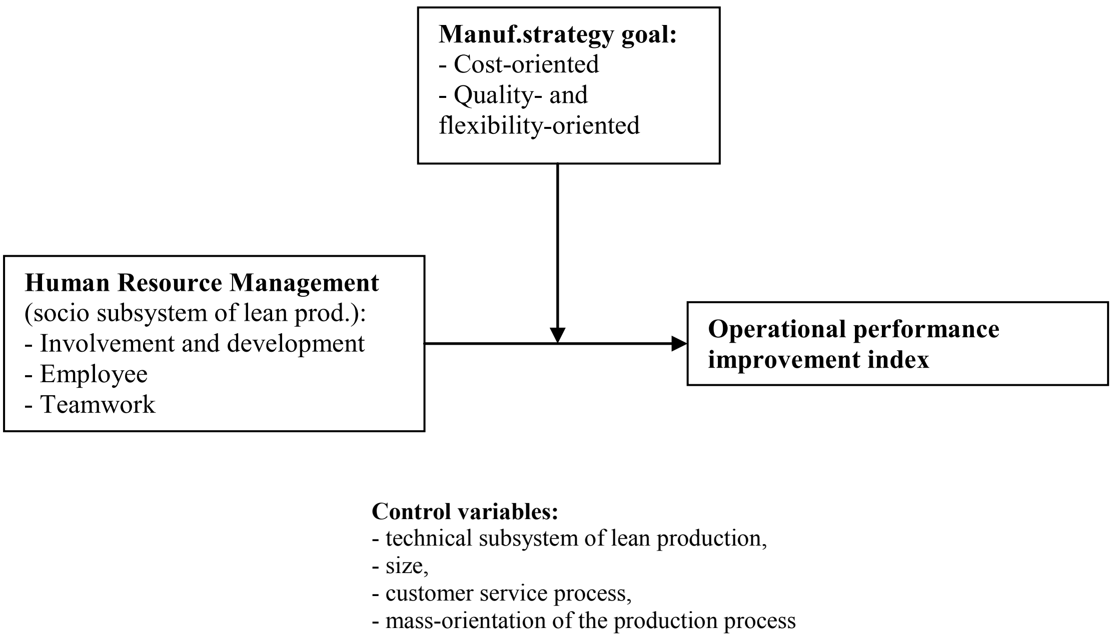
7.3. Efficiency of Use of Human Resource Management Practices

According to the assumption of Hypothesis 2, quality- and flexibility-oriented lean manufacturers make more efficient use of HRM practices than cost-oriented lean manufacturers do. By more efficient use it is meant that HRM practices' contribution to operational performance indicators' improvement is larger in extent at quality- and flexibility-oriented lean manufacturers than at cost-oriented lean producers. Hypothesis 2 is tested by investigating the moderating effect of manufacturing strategy goals. Group comparisons are performed first (7.3.1), followed by the analysis of the interaction effect (7.3.2).

7.3.1. Group Comparison

A group comparison involves the classification of the sample into groups according to the moderator variable. A moderating effect is said to exist if there is a statistically significant difference between the groups with respect to the coefficients between the predictor and dependent variables. This method will capitalize on the manufacturing strategy goals (nominal variables) defined in connection with Research Question 1. Figure 7.1 shows the structure of the process.

Figure 7.1. Testing Hypothesis 2 – the moderating effect



The moderator variable is the manufacturing strategy goal, the explanatory variable is the three HRM factors (Involvement and development, Employee, Teamwork), and the dependent variable is the Operational performance improvement index. The analysis also involves the Technical subsystem of lean, Size, Technology, the Customer service process and the Mass-orientation of the production process.

Hypothesis 2 can be tested by running on each group (distinguished by the manufacturing strategy goal pursued) a regression that involves the above explanatory variable and control variables, and then comparing the coefficients of the resulting regression equations. The samples were suitably sized for running the models. The rule of thumb for sample sizes in regression analyses is: *sample size = 30 + 8 x # of explanatory variables* or *sample size = 104 + # of explanatory variables*.

Prior to running the regression model, the explanatory and control variables need to be checked for correlations. Table 7.7 shows the correlations between the explanatory variables.

Table 7.7. Correlations between the explanatory and the control variables at lean manufacturers (N=270)

	Involvement & devel.	Emplo-yee	Team-work	Size (LOG)	Technology	Technical subs. of lean prod.
Involv. & devel.	1					
Employee	0.310**	1				
Teamwork	-0.005	-0.016	1			
Size (LOG)	0.175**	-0.095	0.092	1		
Technology	0.069	0.050	-0.005	0.19	1	
Techn.subs. of lean	0.420**	0.189**	-0.041	0.141*	0.001	1

Notes: ** significant at the 0.01 level, * significant at the 0.05 level

Table 7.7 reveals that even though the correlation is significant for several variable pairs, none of the relations is strong. A generally accepted means of determining the presence of multicollinearity is the VIF (*variance inflation factors*) value. The VIF values were calculated for the regression model run on the entire sample (N=397), involving all explanatory and control variables. The VIF values' being clustered around 1 (rightmost column of Table 7.8) also indicate the absence of multicollinearity from the model.

Multiple linear regression models were run for the purposes of the group comparison: the effect of the explanatory variables was evaluated on the entire sample (Table 7.8), as well as on the two subsamples with differing manufacturing strategy goals (Table 7.9). In all three cases, the variables were introduced into the model in two phases: first the control variables (Model 1), then the HRM variables (Model 2). Table 7.8 reports on the effect of the explanatory and control variables on the Operational performance improvement index as evaluated on the entire sample.

Model 1 in Table 7.8 evinces that there are only two control variables that have (some sort of) an influence (customer service process, technical subsystem of lean production).

Table 7.8. The effect of HRM practices and the control variables – regression model on the entire sample

Variables	**Entire sample**				
	Model 1		**Model 2**		
	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	**VIF**
Dependent variable – Operational performance improvement index					
Constant					
Constant	0.065 (0.332) (0.197)	0.844	0.131 (0.339) (0.385)	0.700	1.098
Control variables					
Size	-0.030 (0.122) -0.014 (-0.242)	0.809	-0.062 (0.126) -0.030 (-0.493)	0.622	1.098
Mass-orientation of the production process	0.057 (0.104) 0.033 (0.550)	0.583	0.110 (0.108) 0.063 (1.105)	0.311	1.108
Customer service process	***0.167 (0.086) 0.117 (1.936)***	***0.054***	***0.167 (0.088) 0.117 (1.895)***	***0.059***	***1.106***
Technology	-0.043 (0.039) -0.067 (-1.084)	0.297	-0.043 (0.039) -0.068 (-1.091)	0.276	1.106
Technical subsystem of lean production	**0.391 (0.093) 0.259 (4.213)**	**0.000**	**0.369 (0.102) 0.244 (3.614)**	**0.000**	**1.319**
HRM factors					
Involvement and development			0.016 (0.020) 0.057 (0.833)	0.405	1.367
Employees			-0.015 (0.025) -0.037 (-0.574)	0.566	1.175
Teamwork			0.029 (0.043) 0.040 (0.670)	0.503	1.025
R-squared	0.094		0.098		
adjusted R-squared	0.077		0.071		
std. error	0.670		0.672		
F	5.456		3.546		
Sig.	0.000		0.001		

Notes: **significant at the 0.05 level**, ***significant at the 0.1 level***

It is in Model 2 that the HRM practices are introduced. Model 2 is significant (F=3.546, p=0.001), even though the adjusted R-squared value (0.071) suggests that the model's explanatory power is weak. What is more, its explanatory power further declined after having introduced the HRM variables.

In Model 2 of Table 7.8, the customer service process has a weak (p=0.059), while the enhancement of lean's technical subsystem has a strong and significant (p=0.000) influence on the Operational performance improvement index. **None of the HRM factors has a significant effect**.

Having divided the sample by manufacturing strategy goals, further linear regression models were run, involving the explanatory and control variables listed in Table 7.8. In Table 7.9, the results of the cost-oriented subsample are shown on the left, while those of the quality- and flexibility-oriented subsample appear on the right.

The model is significant on the subsample of both the cost-oriented (F=2.214, p=0.032), and the quality- and flexibility-oriented (F=2.087, p=0.040) lean manufacturers.

The adjusted R-squared value is low in both cases. The model exhibits a somewhat stronger explanatory power with respect to cost-oriented lean producers (adjusted R-squared=0.081) than quality- and flexibility-oriented lean manufacturers (adjusted R-squared=0.052). As compared to the analyses performed on the entire sample (adjusted R-squared=0.071), cost-oriented lean manufacturers yielded a higher, while the other group yielded a lower adjusted R-squared value.

The control variables were introduced first in this series of analyses, as well. The control variables affect the two groups differently. As regards cost-oriented lean manufacturers, size (p=0.026) and the technical subsystem of lean production (p=0.030) have a significant effect, and mass-orientation was also detected to have a weak influence (p=0.084). With respect to quality- and flexibility-oriented lean manufacturers, only a single control variable showed a significant effect: the technical subsystem of lean production (p=0.011). The technical subsystem of lean production is the only control variable that was found to have an influence on performance improvement among lean producers in general, i.e. irrespective of the manufacturing strategy goal pursued. Examined on the entire sample, the customer service process also exhibited a significant (at the p=0.1 level) relationship, yet this relation is absent from the analyses run on the subsamples we defined according to manufacturing strategy goals. Two of the variables (size, mass-orientation) present at cost-oriented lean manufacturers (size, mass-orientation) did not appear on the entire sample. The evaluation suggests that the control variables that affect lean manufacturers' performance differ by the manufacturing strategy goal they pursue.

From the analyses it transpires that **HRM practices do not contribute to the improvement of operational performance with either manufacturing strategy goal**.

Table 7.9. The effect of HRM practices and the control variables – regression models by strategic goal

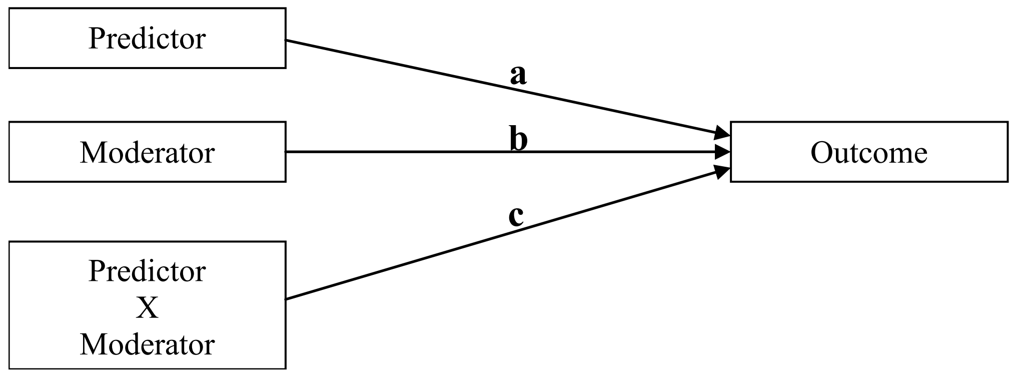
Variables	Cost-oriented lean manufacturers				Quality- and flexibility-oriented lean manufacturers			
	Model 1		Model 2		Model 1		Model 2	
	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.
Dependent variable – Operational performance improvement index								
Constant								
Constant	0.691 (0.462) (1.495)	0.138	0.772 (0.487) (1.595)	0.116	-0.337 (0.450) (-0.748)	0.455	-0.260 (0.458) 0.568	0.571
Control variables								
Size	**-0.380 (0.166) -0.211 (-2.292)**	**0.024**	**-0.409 (0.181) -0.228 (-2.263)**	**0.026**	0.230 (0.170) 0.108 (1.357)	0.177	0.207 (0.175) 0.097 (1.184)	0.238
Mass-orientation of the production process	***0.289 (0.162) 0.174 (1.779)***	***0.078***	***0.291 (0.166) 0.175 (1.745)***	***0.084***	0.041 (0.141) 0.023 (.289)	0.773	0.050 (0.144) 0.028 (0.346)	0.730
Customer service process	0.177 (0.119) 0.139 (1.484)	0.141	0.183 (0.127) 0.144 (1.438)	0.153	0.105 (0.121) 0.071(0.872)	0.385	0.085 (0.123) 0.058 (0.696)	0.488
Technology	-0.052 (.053) -0.095 (-.974)	0.332	-0.055 (0.055) -0.101 (-1.006)	0.317	-0.068 (0.056) -0.100 (-1.215)	0.226	-0.075 (0.057) -0.111 (-1.328)	0.186
Technical subsystem of lean production	**0.376 (0.138) 0.256 (2.727)**	**0.007**	**0.335 (0.152) 0.228 (2.204)**	**0.030**	**0.351 (0.126) 0.230 (2.784)**	**0.006**	**0.363 (0.142) 0.238 (2.561)**	**0.011**
HRM factors								
Involvement and development			0.023 (0.026) .091 (0.866)	0.389			0.003 (0.028) 0.010 (0.108)	0.914
Employees			-0.013 (0.040) -0.037 (-0.334)	0.739			-0.015 (0.034) -0.037 (-0.443)	0.658
Teamwork			-0.010 (0.058) -0.016 (-0.169)	0.866			0.076 (0.060) 0.099 (1.253)	0.212
R-squared	0.141		0.148		0.090		0.101	
adjusted R-squared	0.100		0.081		0.060		0.052	
std. error	0.583		0.589		0.707		0.710	
F	3.453		2.214		2.996		2.087	
Sig.	0.006		0.032		0.013		0.040	

Notes: **significant at the 0.05 level**, ***significant at the 0.1 level***

7.3.2. Analysis of the Interaction Effect

The analysis involves three causal relationships (Figure 7.2): the effect of the predictor (a), the effect of the moderator (b) and the interaction of the predictor and the moderator (c). If path (c) is significant that suggests the presence of a moderating effect. The moderating effect, the presence of which is indicated by the non-standardized parameter's being significantly different from zero, can be evaluated based on the value and the significance level of the parameter pertaining to the variable that represents the interaction.

Figure 7.2. The model for evaluating the interaction effect

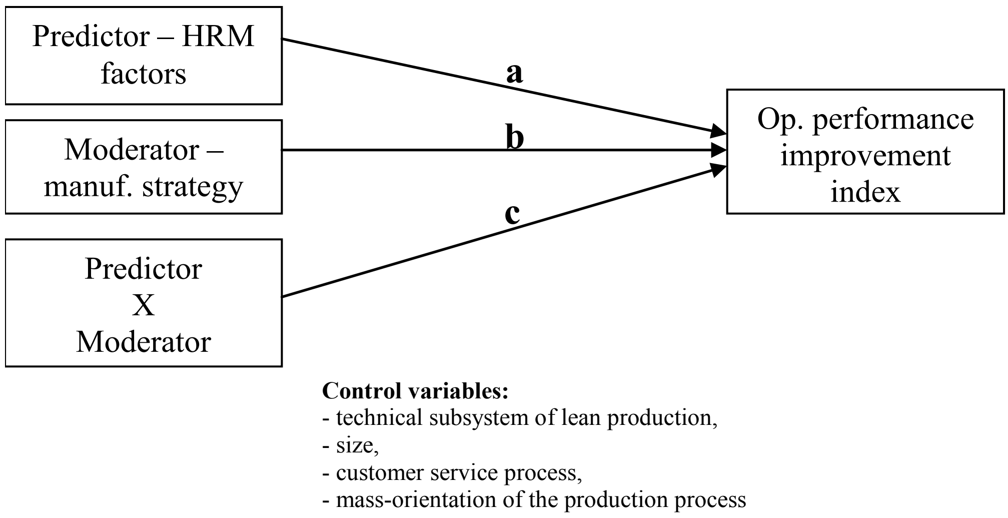


Source: Baron and Kenny 1986 p. 1174

The question at the core of this investigation is whether a relationship exists between the predictor and the moderator (Figure 7.2). In the testing of Hypothesis 2, as illustrated by Figure 7.3, the HRM factors constitute the predictor variables and manufacturing strategy goals are the moderating variable. The linear regression model for investigating the interaction effect involves the control variables, the HRM factors, the manufacturing strategy goals and the new variables generated for this very purpose from the HRM factors and the manufacturing strategy goals (as the product of the existing values).

The interaction model was built up in three steps. First the effect of the control variables was examined, then the HRM factors were introduced, and finally the variables representing the interaction were incorporated into the model, as well. The results of the interaction effect's evaluation are summarized in Table 7.10.

Figure 7.3. Testing Hypothesis 2 – the interaction effect



All three models are significant, yet the value of the adjusted R-squared declined with each step, with a final value of 0.07 for the interaction model. In the interaction model – as well as in the other two models – it is the technical subsystem of lean production (significant, p=0.001) and the customer service process (significant at the p=0.1 level) that affect the Operational performance improvement index. Neither individually nor in interaction with manufacturing strategy goals do the HRM factors influence the Operational performance improvement index.

Table 7.10. Evaluation of the interaction effect

Variables	Entire sample					
	Control variables		Control variables and explanatory variables		Interaction model	
	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.	Non-standardized coefficient B and Std.(Error) Standardized coefficient Beta and (t)	Sig.
Dependent variable – Operational performance improvement index						
Constant						
Constant	0.065 (0.332) (0.197)	0.844	0.131 (0.339) (0.385)	0.700	0.126 (0.341) (0.370)	0.711
Control variables						
Size	-0.030 (0.122) -.014 (-.242)	0.809	-0.062 (0.126) -0.030 (-.493)	0.622	-0.053 (0.128) -0.026 (-0.410)	0.682
Mass-orientation of the production process	0.057 (0.104) 0.033 (0.550)	0.583	0.110 (0.108) 0.063 (1.105)	0.311	0.110 (0.109) 0.063 (1.016)	0.311
Customer service process	***0.167 (0.086) 0.117 (1.936)***	***0.054***	***0.167 (0.088) 0.117 (1.895)***	***0.059***	***0.148 (0.089) 0.104 (1.657)***	***0.099***
Technology	-0.043 (0.039) -0.067 (-1.084)	0.297	-0.043 (0.039) -0.068 (-1.091)	0.276	-0.047 (0.040) -0.073 (-1.162)	0.247
Technical subsystem of lean production	**0.391 (0.093) 0.259 (4.213)**	**0.000**	**0.369 (0.102) 0.244 (3.614)**	**0.000**	**0.358 (0.103) 0.237 (3.482)**	**0.001**
HRM factors						
Involvement and development			.016 (.020) .057 (.833)	0.405	-0.003 (0.028) -0.009 (-0.095)	0.924
Employees			-.015 (.025) -.037 (-574)	0.566	0.009 (0.042) 0.022 (0.207)	0.836
Teamwork			.029 (.043) .040 (.670)	0.503	-0.042 (0.065) -0.058 (-0.635)	0.526
Involvement and development X Strategy Dummy					0.031 (0.034) 0.086 (0.903)	0.368
Employees X Strategy Dummy					-0.033 (0.053) -0.064 (-0.626)	0.532
Teamwork X Strategy Dummy					0.120 (0.086) 0.126 (1.383)	0.168
R-squared	0.094		0.098		0.108	
adjusted R-squared	0.077		0.071		0.070	
std. error	0.670		0.672		0.673	
F	5.456		3.546		2.835	
Sig.	0.000		0.001		0.002	

Notes: **significant at the 0.05 level**, ***significant at the 0.1 level***

7.4. Interpreting the Results

This chapter consists of four sections: Subchapter 7.4.1 reviews our findings concerning manufacturing strategies, and then 7.4.2 interprets the characteristics of the lean production system by manufacturing strategy goal. Section 7.4.2 comprises several subchapters: first comes an overview of the characteristics of lean manufacturers' technical subsystem and performance according to manufacturing strategy goal (7.4.2.1), followed by the discussion of the intensity (7.4.2.2) and efficiency of use (7.4.2.3) of the practices that the socio subsystem is comprised of. Subchapter 7.4.3 reports on our findings related to the control variables. Having interpreted the dissertation's empirical findings, Subchapter 7.4.4 proceeds to highlight those aspects of my literature review that contribute to the Hungarian and international literature.

7.4.1. Manufacturing Strategy Configurations in the Late 2000s

The investigation of manufacturing strategy goals was a prerequisite for dealing with Research Questions 2 and 3, and yielded results that are of value in themselves.

Drawing upon Roth and Miller's (1994) taxonomy, the manufacturing firms of the late 2000s can be characterized by two types of manufacturing strategy: **the cost-oriented (with a 44% share) and the quality- and flexibility-oriented (56%) strategies, which bear close resemblance to Porter's competitive capabilities of cost-leadership and differentiation, respectively.**

Similar to Roth and Miller's (1994) study concerning the 1990s, my research also identified the cost-oriented group, for whom costs/low prices are a top competitive priority. Not only is the cost-oriented (originally Caretaker) strategy present, but its share is a significant one, as well. My quality- and flexibility-oriented manufacturing strategy may be described as a blend of Miller and Roth's Marketeers and Innovators. Thus an important change in comparison to the 1990s is that apart from the cost-oriented group, now there is only one manufacturing strategy instead of two. In this second manufacturing strategy, variety and speed have „caught up" with quality. Comparing my two manufacturing strategies, it is apparent that new product development is much more a point of emphasis in the quality- and flexibility-oriented strategy than in the cost-oriented strategy. As far as the cost-oriented strategy is concerned, new product development gets the least attention out of all the criteria. This remarkable difference may also signify that the development of new products is limited to the other group of firms. The clearest indication, however, that new product development has been pushed into the background is that whereas once it was the distinctive characteristic of a separate genre of firms (Innovators, namely), now this goal is the one with the lowest score even in the quality- and flexibility-oriented group.

Cagliano et al. (2005) examined manufacturing strategy configurations and their changes on data from the first three rounds of IMSS. Unfortunately their research sheds no light upon competitive priorities, yet one can make reasonable estimates about the frequency (relative proportions in the sample) of the various configurations. Based on their data pertaining to the period up to 2001, they concluded that out of the four configurations they identified, the cost-oriented strategy had been losing ground, and that the period between 1992-2001 had been dominated by the product-based strategy (closely resembling our quality- and flexibility-oriented category). My results suggest that in the fifth round of the IMSS survey, the quality- and flexibility-oriented category is still dominant, yet there has remained only one other type of strategy (constituting a rather large proportion): the cost-oriented one. Thus even if there had been a tendency/hint that cost-orientation had been in retreat, it was once again gaining ground during the late 2000s.

Similar to Frohlich and Dixon (2001), I identified the cost-leadership and differentiation strategies. As regards the cost-oriented strategy, the difference between the two researches lies in the frequencies detected: I found that it was present in 44% of the firms, while they reported 20 to 30%. Thus my results suggest that this manufacturing strategy has gained ground in the meantime. As concerns the interpretation of the differentiation strategy, however, the differences are substantial. Frohlich and Dixon (2001) suggest that an important change between the early and the late 1990s was that Marketeers, the category representing the differentiation strategy, had been replaced by Designers. They add that Designers compete in a wider range of competitive capabilities than Marketeers, and put a very strong emphasis on the offering of new products (4.14) and a wider product range (4.16). This change they attribute to the expansion of certain industries (e.g. electronics) and the more rapid pace of changes in the business environment (e.g. the ability to develop new products has become critical). They also note that the category of Innovators, equated with the focus strategy, had disappeared by the end of the 1990s. Which my results appear to confirm insofar as a separate group of Innovators with a focus on product development only could not be detected at the end of the 2000s, either. The differentiation strategy of the late 2000s attaches great importance to nearly all the competitive capabilities: quality, time, variety and services are all stand out. An important change is nonetheless that the competitive capabilities that Designers prioritized have been pushed into the background, and are now the least important ones among the goals of the quality- and flexibility-oriented group (e.g. offer new products 3.53, wider product range 3.70).

Finally, Hallgren and Olhager's (2009) research is worthy of our attention because it strengthens the presumption advocated in numerous papers that only two strategies can be distinguished, namely cost-oriented and differentiation. The authors relied on a smaller number of variables, but the ones they used to operationalize the strategies are the very ones along which my strategies differ: low price and low manufacturing cost (cost-leader), and quick changeover and volume flexibility (differentiator).

In summary it can be concluded that in the late 2000s – i.e. as reflected by the IMSS V survey –, **manufacturing strategies on the sample of large manufacturing firms are bipolar: the cost-leadership and the differentiation manufacturing strategies can be identified**. My results suggest **that the cost-oriented strategy has significantly gained in importance**. The number of firms pursuing this strategy, in which low prices have a prominent role in both relative and absolute terms, may be as much as twice the former figure (44% instead of approx. 20%). The last decades have been witness to some serious changes in the differentiation strategy. In the **quality- and flexibility-oriented strategy, interpreted as the differentiation strategy of the late 2000s, quality, time, variety and services all are all of prominent importance.**

What are the causes behind this polarization? How should the prevalence of the individual competitive priorities be interpreted? How is all this related to manufacturing strategies?

Ever since the Sand Cone model – the successor of trade-off theories – and the lean system (and other modern process management concepts) started to become widespread, quality has become more and more of a qualifying criterion. Which is also mirrored in our results pertaining to manufacturing strategies: the two quality variables ranked 1st and 2nd in relative importance for the quality- and flexibility-oriented group, and 2nd and 3rd for the cost-oriented group. The importance of quality-related expectations underpins the „must have"-status of quality. Rather surprising is, however, the difference in its absolute importance between the two groups.

As early as several decades ago, Stalk (1988) already considered the time factor to be on par in terms of importance with productivity, quality and innovation. He suggests a sort of inverse relationship between time and cost, and citing examples from the practice of Japanese firms underlines that the rapid expansion of firms' product variety, the quick launching of products and quick changeovers in the production process are critical. In earlier Operations Management research, the competitive priority of swiftness probably received less attention. Its increased importance should, nonetheless, hardly come as a surprise. Contrasting Demeter's listings of competitive capabilities from 1999 (price, reliability, quality, flexibility, service) and 2010 (price, reliability, quality, flexibility, swiftness), it is apparent that swiftness had earned the status of a separate factor in the listing intended to reflect the new, changed competitive environment. The recent study of Simchi-Levi et al. (2012) draws attention to several phenomena in everyday business life that indicate the increased prominence of flexibility. The increased importance of regional distribution centers, the endeavor to locate both production and outsourced activities in the vicinity of the target market, and the currency of the flexible supply chain concept – the cornerstones of which are flexible production, producing the widest possible range of products at the same location (sometimes even despite higher costs) and quick response to new procurement methods – all serve to ensure quick responses and variety. The significance of regionalization is emphasized in a Hungarian paper, as well (Gelei, 2009). My results indicate that it is firms pursuing a differentiation strategy for which expectations related to swiftness, regionalization challenges and time-based competition may be of significance.

Another important dimension of the differentiation strategy are services. This is a competitive priority that has disappeared from the list of current competitive capabilities by the end of the 2000s (see Demeter's lists int the preceding paragraph). Which might lead us to conclude that this factor has lost in importance. Numerous tendencies, like servitization, seem to suggest, however, that more and more key market actors are making greater and greater efforts to improve their customer service activities (Szász and Demeter 2011). My results may indicate that servitization is important to the quality- and flexibility-oriented strategy.

The differentiation strategy is characterized by a certain duality with respect to product development: superior product design and quality is prominent, yet the offering of new products more frequently appears less important. What this may reflect is the recent tendency of very extensive outsourcing and offshoring (even contract manufacturing) resulting in production managers' actually being responsible for production and manufacturing „only". Innovation and product development competencies are separated (oftentimes even geographically) within the organization. The high score achieved by superior product design suggests that production managers are primarily interested in manufacturability.

Another interpretation of the low scores assigned to the more frequent offering of new products rests on the supposition of an opposite tendency, namely that the frequent introduction of new products has become a basic requirement by now. Innovation capability having become a basic requirement, it is present in a wide circle of firms and cannot be considered a distinctive feature any more.

The status of cost-leadership as an important order-winning criterion has always been an axiom of Operations Management, and the crisis has acted to further strengthen the role of prices, as the flash report on the 2009 survey of the Competitiveness Research Centre also points out (Chikán et al. 2010). Relying on the same database, Demeter and Szász (2012a, 2012b) suggest that the increased importance of prices cannot be associated with any of firms' generic characteristics: it is independent of company size, ownership and export capability. I did not manage to find in the international Operations Management literature any works dealing with how the crisis may have affected cost-leadership as a competitive priority.

My results indicate the gaining ground of the cost-oriented goal. Apparent is, as well, that firms pursuing differing manufacturing strategy goals are affected differently by the tendencies of and the changes in the business environment.

Even though the identification of manufacturing strategy goals was an important step in my research, it was after having compared the two- and the three-cluster variants that I decided for the two-group solution. By creating further clusters (4-5 altogether), another – maybe even a better – classification might have been possible (the excessive segmentation of the sample disregarded). What is more, Frohlich and Dixon (2001) call our attention to potential geographical effects, e.g. the higher proportion of cost-oriented manufacturers in Asia.

7.4.2. Investigation of Lean Manufacturers by Manufacturing Strategy Goal

A number of authors have emphasized the effects of strategy in lean environments, and urged research into the matter (Batt 2007; Hines, Holweg, and Rich 2004; Sakakibara et al. 1997; Shah and Ward 2003). So far, lean-related research has been limited to a single component of manufacturing strategy, namely process choice, and its relationship to production techniques. And even that domain is utterly lacking large-sample studies. The investigation of manufacturing strategy goals in a lean environment and the large-sample, questionnaire-based methodology both are novel in the literature.

The relationship between manufacturing strategy goals and the lean production system is a focal point of this study. The HRM literature – particularly during the 1990s – often relied on the implicit assumption that the differentiation strategy is coupled with quality management (as a typical modern production concept), and the cost-leadership strategy with traditional mass production. **The lean production environment (as another modern production concept) is not exclusive to either cost-leaders or differentiators**. What is more, the examination of process choice revealed that not even the mass-orientation of production is related to the lean environment. Cost-oriented (non-)lean mass producers and quality- and flexibility-oriented (non-)lean mass producers do equally exist. **From amongst the modern production concepts, the lean system cannot be exclusively linked to either manufacturing goals or process choice.** Thus the way of thinking that formerly linked the differentiation strategy to modern production concepts has been superseded, and at the same time the issue has arisen how HPWS, basically considered to be a part of modern productions systems, should be interpreted in a cost-leader environment.

7.4.2.1. Technical Subsystem and Performance Improvement

The comparison of the technical subsystems and the operational performance improvements of cost-oriented vs. quality- and flexibility-oriented lean manufacturers suggests that:

- **quality- and flexibility-oriented lean manufacturers make more intensive use of lean production techniques;**
- **quality- and flexibility-oriented lean manufacturers perform better in terms of operational performance improvement on the majority of indicators.**

At this point I have to underline that this part of my study is not intended to examine how manufacturing strategy goals affect the lean production system. It „merely" serves to present the extent to which lean manufacturers pursuing different manufacturing strategy goals differ in their use of certain technical practices and in the performance improvement achieved.

What might be the explanation for the difference detected in the technical subsystem of lean production according to manufacturing strategy goal?

For a potential explanation, we might fall back on contingency theory, as also proposed by Sousa and Voss (2008) with respect to mature Operations Management concepts. In my research framework, manufacturing strategy goals constitute the contingency, and the technical elements of lean production represent the action programs. Lean manufacturers have to face profoundly different contingencies – external contingencies i.e. customer expectations –, which in turn translate into dissimilar competitive priorities and manufacturing strategy goals.

Possibly it is their customers' wide-ranging set of expectations that urge quality- and flexibility-oriented lean firms to improve multiple aspects of their operations. This wide set of high expectations might reflect the environment (see the first paragraph of Subchapter 6.4.1) that the lean literature often – though without having actually researched it – makes references to, e.g. changes in the general environment put quality, flexibility and involvement in the spotlight. Given the knowledge that lean might induce significant improvements in several competitive capabilities (as already indicated in Subchapter 2.2), the lean system is one of the options that these firms might be driven to by the need to develop. The fact that the two programs (process focus and quality improvement) that these firms concentrate on from amongst all the technical elements are the ones that may improve the very performance measures (mix flexibility, delivery time, delivery reliability) that might support their manufacturing strategy goals (flexibility and swiftness) lends credit to this train of thought. Apart from low prices, cost-oriented lean manufacturers do not have to face any customer expectation that would put them under serious pressure to re-think their processes. Thus, in comparison to the other group, they should not be expected to intensely use the practices or exhibit significant performance improvement. The contingency theory approach suggests that **it is where more than one competitive capability has top priority simultaneously that one can expect lean techniques to be intensely used.**

In view of the above argumentation, my conclusion pertaining to the implicit assumption of the HRM literature that the differentiation strategy is necessarily linked to modern process management (e.g. TQM, quality management) appears to be in need of refining. True enough, the exclusivity suggested by the assumption does not hold, for we may encounter lean manufacturers among firms with a cost-oriented strategy as well as among those with a quality- and flexibility oriented strategy. However, the fact that the structure of the technical subsystem substantially differs by manufacturing strategy goal does lend some credibility to the close relationship between the differentiation strategy and modern process management concepts. The technical subsystem of lean is much more extensive in a quality- and flexibility-oriented environment. These considerations of mine are, nonetheless, quite far from what Hallgren and Olhager (2009) found. Having contrasted the lean and agile systems, they established that the lean system is very closely connected with the cost-leadership strategy. The differentiation strategy can only be associated with the agile system.

My findings also contribute to the exploration of the relationship between contingencies and the lean system. The impact of process choice, as one of firms' strategic decisions in manufacturing, has already been pointed out by multiple researchers, proposing that a more intensive – and more efficient – use of the lean production techniques is to be expected in more complex processes and mass production environments (Funk 1995, James-Moore and Gibbson 1997, Hobbs 1995, White 1993). My findings evince that the use of lean techniques also differs by manufacturing strategy goal – quality- and flexibility-oriented lean manufacturers tend to rely on them more extensively.

Finally, the work of Matyusz (2012) shows that the differences in configuration do not necessarily arise as a result of differing manufacturing strategy goals. Matyusz (2012) proves that a number of contingency factors have a significant effect on the intensity of use of action programs at manufacturing firms. The variables I regarded as the technical elements of lean were categorized as Process Organization and Quality Practices in Matyusz's paper. These action programs were affected by technological level (process organization, quality practices), customer orders (process organization), quality focus (quality practices) and sustainability focus (quality practices). Though he also involved order-winning criteria in his study, and even identified four related contingency factors (cost, quality focus, flexibility focus and sustainability focus), he managed to corroborate only the relationship between quality focus/sustainability and quality practices. Which quite clearly shows that customer expectations do not have much of an influence on action programs – directly, at least. Even though the differences between the samples (i.e. manufacturing firms vs. lean manufacturers) and the operationalization methods used (i.e. factor analysis of order-winning criteria vs. taxonomy) prohibit us from extending Matyusz's (2012) train of thought to the sample I analyzed, his study still illustrates that under certain circumstances, the direct effect that customer expectations have on the use of action programs is rather limited. Numerous external and internal contingencies have a more significant influence, though indirectly in some cases.

Contingencies have received little attention in lean research so far, therefore I am inclined to even regard the comparison of differing situations (e.g. processes, manufacturing strategy goals) as an advancement. My research has confirmed that manufacturing strategy goals may influence best practices. Clearly there is a need for further research into the lean system, for our present knowledge is limited. An important future research avenue could be **the examination of a wider circle of contingencies and the direction of the effects**.

7.4.2.2. HRM System – Intensity of Use

The comparison of the two groups of lean manufacturers distinguished by manufacturing strategy goal **did not detect a difference in the intensity of use of HRM practices**. **Hypothesis 1** of my study, which assumed that quality- and flexibility-oriented lean manufacturers would make more extensive use of HPWS practices than cost-oriented lean manufacturers, **could not be confirmed**.

The socio subsystem of lean manufacturers appears to be homogeneous, there are only a couple of minor phenomena – some of which contradict our expectations – worthy of pointing out:

- quality improvement and decentralization (in its relation to the former) receive somewhat emphasis at quality- and flexibility-oriented lean manufacturers, and
- rotation, training and teamwork (as related to multiskilled workers) have a more important role at cost-oriented lean manufacturers.

In light of the lack of a significant difference in the use of HRM practices, my results suggest that the **differing lean system configurations that lean manufacturers build according to the manufacturing strategy goal they pursue actually consist of differing technical subsystems coupled with a uniform socio subsystem**. This finding refines the literature on several points.

My research refines **Operations Management's** existing assumptions pertaining to the implementation and enhancement of the lean system.

The advocates of lean consistently argue for the – continuous – enhancement of the lean system, that is, they suggest that its socio-technical practices should be relied upon more and more intensively. My results advise against regarding this as a universally valid recommendation, for the degree of enhancement of the lean production system's practices is not uniform. The example of quality- and flexibility-oriented lean manufacturers tells us that the enhancements of lean techniques has not been accompanied by the more intense use of socio practices. One might maintain that the lean production system is an integrated system, but it seems that the enhancement of the socio side has a certain limit in present business practice.

My results are also relevant to the **conclusions pertaining to the currency of HPWS practices**. Operations Management researchers (Oliver et al. 1994) as well as those dealing with the HPWS system have frequently underlined that HPWS practices are in widespread use (Makó, Illéssy, and Csizmadia 2008; Valeyre et al. 2009a; 2009b). Whereas the former researchers referred to the general prevalence of HPWS practices, the latter consider them to be the key elements of a widely used work organization model (lean model). My results confirm the latter statement: HPWS is present in a large proportion of a homogeneous set of firms (270 lean manufacturers out of 397 large manufacturing firms). This homogeneous circle of firms is characterized by an average to above-average intensity of use of HPWS practices (Table 7.11).

Despite its narrow focus, my research still contests the opinion of those researchers (Godard 2004; Hesketh and Fleetwood 2006; Wall and Wood 2005) who doubt the popularity of HPWS. We can now name a circle of firms to which their conclusions certainly do not apply: large manufacturing firms that also rely on lean production techniques use HPWS with above-average intensity. If, however, we accept that HPWS practices are more widespread in the manufacturing sector than in the services sector (Ordiz-Fuertes and Fernández-Sánchez 2003) and add that it is the practice of larger manufacturing firms that the lean system pervades, then it becomes apparent that a rather wide circle of firms probably makes less intensive use of HPWS practices.

Due to the reduced sample (large manufacturing firms), my findings about the currency of the HPWS system cannot be generalized. What is more, they require further refinement considering that the research network expects the sampling to specifically involve the best-performing firms. Thus the use of HPWS might be over-represented to a certain degree among the firms included in the sample.

My results also enable us to **examine how the intensity of use of HPWS practices in lean environments has developed in the course of the last decades**. Though one should be especially cautious about drawing conclusions here, Table 7.11 still draws attention to an interesting phenomenon. If we accept that among the lean manufacturers in the IMSS V sample, the intensity of use of HPWS practices is above the average, then Table 7.11 shows that as far as the lean environment is concerned, HPWS practices have exhibited a uniform intensity of use throughout the course of the last couple of years/decades.

Table 7.11. Intensity of use of HPWS practices in a lean environment

HRM practices	Variable	IMSS V	IMSS IV	Italian sample
		2008/2009	2005	1996
		Lean manufacturers	Advanced lean manufacturers	Lean firms
Hierarchy	Organizational levels	3.83	3.64	n.a.
Quality improvement, involvement	Involved in process improvement	3.44	n.a.	3.34 (employee improvement suggestions)
	Continuous improvement	3.84	3.58	3.58
Teamwork	Functional teams	58.23	58.19	2.9 (supporting teamwork)
Training	Training (log)	25.99	35.16	n.a.
Job enhancement, rotation, job enlargement	Multiskilled workers	47.20	56.37	3.45
	Rotation	3.17	3.42	n.a.
Decentralization	Autonomy	3.08	3.25	n.a.
	Delegation	3.30	3.43	3.43
Source		present research	Losonci and Demeter (2010)	Forza (1996)

That is, while it seems reasonable to expect the further spread of the lean production system to be accompanied by the gaining ground of the HPWS system, the above-average intensity of use of HPWS practices in lean environments appears to remain constant. Which may indicate that the production managers of the individual companies are content with a certain sufficient level of the HPWS system. The around-average values might, however, just as well signify that with the enhancement of the lean system, respondents are becoming more and more aware of the areas where they still need improvement. Thus the near-average values may also suggest, especially in light of the questionnaire's peculiarities (the effort put into the action program during the last three years), that respondents are lagging behind the desirable level with respect to HRM practices.

My findings have a bearing on the **synthesizing and best fit approaches** appearing in the Operations Management and HRM literature. Earlier research proved, or at least proposed that the HRM systems of manufacturing firms differ according to the strategy pursued. As regards lean environments, my conclusions fail to support the findings of either Jayaram et al. (1999), advocates of the synthesizing approach, or Santos (2000), who put emphasis on the best fit approach. Even though I did not specifically address the stages of manufacturing strategy in my study, lean manufacturers appear to be so homogeneous with respect to their socio subsystems that it seems highly unlikely that proof could have been acquired for the assertion of Sakakibara et al. (1997) stating that the lean production system (JIT) employs differing work organization systems at the 3rd and the 4th stages of manufacturing strategy.

There may be further reasons for our not having been able to confirm our assumptions with regard to manufacturing strategy goals:

- Quality- and flexibility-oriented firms **may have failed to recognize how the socio subsystem might contribute to improving their performance** (quality and swiftness, primarily), and thus do not strive to make more intensive use of its practices. (This is actually supported by Hypothesis 2.) This argument is also mentioned in some pieces of the HRM literature that deal with the relationship between HRM and performance. The reason why this proposition might be of particular importance to lean manufacturers is that even though everyone keeps preaching about the importance of human resources, Table 7.11 above implies that their attitudes have remained unchanged.
- Worth mentioning are, furthermore, those arguments of the HRM literature in regard of the currency of HPWS that allude to context dependence, according to which it is **firms closely integrated into international competition that devote more attention to the HPWS system**. On our sample, the HPWS system appears to be closely linked to lean techniques, which gives rise to the idea that maybe these two organizational innovations are bound to appear together and in similar operating environments. This reasoning suggests, thus, that **it is the operating environment – and not the firm's strategy – where the true drivers** of the organization's operation reside (see for example the study of Matyusz (2012) on a wide range of manufacturing action programs).
- Firms have little room for maneuver – especially within a given country –, because **the labor markets and technological environments they operate in are similar**. A good example is the survey conducted in the Hungarian electronics sector, which also found that firms operated in highly similar ways (Halaska, 2012; Perényi, Rácz

and Schipper, 2012). My research is based on an international database and focuses on several regions, therefore the differences in labor market conditions and in the technological environment may well be more substantial than within a single country. Regional differences in HRM may be of particular importance.

The above statement does not at all mean, however, that employees are not differentiated under the given labor market conditions. Differentiation and special attention are the „privilege" of jobs that are defined as key positions from a strategic point of view (Huselid and Becker 2011).

- A great part of the decisions pertaining to HRM practices is **beyond the scope of responsibility** – or even the competencies – **of production managers**. For instance the organization's structure, its training scheme and qualification requirements may well reflect considerations other than what would follow from the production system. The production manager may well wish for better-qualified workers, but possibly the training strategy or the labor market situation do not make it possible. Huselid and Becker (2011), as well, mention that even if the significance of HPWS has been recognized, the – efficient – implementation of its practices is not a simple task. They opine that this can often be attributed to the **low quality of HR management**.
- Having jumped on the **„best practice bandwagon"**, cost-oriented lean manufacturers – following the advice of those advocating the full implementation of the lean system – put more effort into socio practices than would be justified. Snell and Dean (1992) pointed out this risk as early as the beginning of the 1990s. That is, the reason why the practice of quality- and flexibility-oriented lean manufacturers does not appear to be different is that cost-oriented firms invest more into HRM than would be reasonable.

In summary we may conclude that the synthesizing approach seems to be valid with respect to the configuration of the lean production system. Contrary to our prior expectations, however, the differences that firms exhibit by manufacturing strategy goal arise in connection with not the socio, but the technical subsystem. In the future, attention should be given to lesser differences in HRM practices: quality improvement and decentralization at quality- and flexibility-oriented lean firms, and the rotation-training-teamwork triplet at cost-oriented lean manufacturers.

Finally, as I have already indicated before, many of the empirical works comparing the socio practices of lean and traditional manufacturers yielded ambiguous findings. One is often left in doubt as to whether the socio subsystem of lean manufacturers indeed differs, as is usually expected, from that of traditional mass producers. As interesting an aspect as it is, contrasting the socio subsystems of traditional and lean firms falls outside the scope of my present research.

7.4.2.3. HRM System – Efficiency of Use

Hypothesis 2 asserts that manufacturing strategy goals affect the efficiency of HRM factors: at quality- and flexibility-oriented lean manufacturers, HRM factors tend to contribute to a greater extent to the improvement of operational performance.

Based on our analysis of the moderating and the interaction effect, it can be concluded that:

(1) at lean manufacturers, HRM factors have no influence on the improvement of operational performance indicators;

(2) the group comparison did not detect that HRM factors would have an impact on the improvement of operational performance indicators;

(3) the analysis of the interaction effect indicates that the relationship between manufacturing strategy goals and HRM practices does not affect the improvement of operational performance indicators.

In light of the above, Hypothesis 2 cannot be accepted. **Lean manufacturers pursuing differing manufacturing strategy goals exhibit similar efficiencies in using their socio subsystems**: **HRM practices do not affect operational performance improvement for either manufacturing strategy goal.**

Though none of the previous studies focused on the lean system, it still seems reasonable to compare my findings to those of the empirical works already discussed in the literature review:

- **Operations Management** works:
  - That of Youndt et al. (1996) was the only paper to corroborate the best fit approach with respect to modern production practices (TQM, more specifically), namely for

the differentiation strategy. My research provides no evidence that the HRM system's efficiency differs by manufacturing strategy goal. Both differentiator and cost-leader lean firms use HPWS elements with above-average intensity, those however do not contribute to operational performance improvement in either group.

- We have the solution to the dilemma of Birdi et al. (2008) concerning the efficiency of HRM practices, as well. The authors suggest that HRM practices have a more significant impact at firms operating in niche markets. Niche-market actors they describe by the duet of swiftness and cost-reduction. Yet not even the core assumption of their dilemma holds, for a niche strategy could not be identified among large manufacturing firms, and especially not with these goals. As justified as it may be to raise the issue of HRM efficiency in a production environment, their conjecture is not even possible to be investigated.
- My research delivers some weak evidence for the proposition of Cua et al. (2001) that in a modern production environment, processes characterized by larger volumes and lower degrees of customization tend to deliver better performance. The group comparison detected a positive relationship with respect to mass production ($p=0.1$) at cost-oriented lean manufacturers, and the interaction effect showed a positive relationship with respect to „mass-like" consumer needs ($p=0.1$) at lean manufacturers. Cua et al. make no reference to HRM practices, but, as we have seen, those do not have any influence, either.

- **HRM papers on HPWS practices:**
  - HRM works employing the synthesizing approach give no attention to the functions significantly affecting HRM (e.g. production). In HRM terms, my research integrates one of the technologies of the production function – i.e. the lean production system – into the synthesizing approach. My results do not confirm the views that highlight the role of training and development with regard to the differentiation strategy (Sanz-Valle et al. 1999; Guthrie et al. 2002). My conclusions bear much more resemblance to the findings of Bae and Lawler (2000), and Ordiz-Fuertes and Fernández-Sánchez (2003), who maintain that in general (viz. not in a lean, and not even necessarily in a production environment), strategic goals do not affect the efficiency of HRM. My research confirmed this conclusion with respect to lean environments.
  - The HRM literature on the best fit approach assigns the differentiation strategy to TQM, emphasizing that the differentiation approach supports the efficient use of the

HPWS system. My findings do not corroborate the – generally held – view that HPWS is linked to the differentiation strategy. What is more, they do not even suggest that lean manufacturers pursuing a differentiation strategy are more efficient in operating their HRM systems.

- Subchapter 4.1.2.2 presented four HRM papers employing the synthesizing approach. All four relied on data collected in the second half of the 1990s, and investigated the practice of a single country (Spain, New Zealand and Korea). My study, though it applies a more narrow focus (production only), still has the advantage of being current and based on an international database.
- An issue that has a tendency to be raised in connection with action programs is the effect of the time factor. Having implemented improvements in an area, its performance effects possibly ensue only after a delay. Which time effect is taken into consideration by the IMSS questionnaire insofar as it enquires about the efforts of the last three years. (Still, the evaluation of the efforts and their results is relative and subjective, and the opinion of the head of the HRM function remains unknown.) Yet the dilemma I have already discussed at an earlier point still remains: certain firms consciously prepare for the lean transformation and train their employees accordingly, and in certain cultures, the labor market requires the development of the workforce to be an area of emphasis to begin with.

The lack of efficiency in the socio subsystem is explained by the same arguments as was the intensity of use of the individual practices. The arguments presented in the preceding chapter were, for the most part, taken from works focusing on just a couple of the functions of (manufacturing) firms. Matyusz (2012) takes a complex approach to manufacturing firms and involves the practices of numerous functions in his research. With respect to improvements in operational performance indicators, he underlines the impact of process organization practices (cost, quality, flexibility, reliability), quality practices (quality, reliability) as well as product development practices (flexibility). As regards HRM practices, he did not manage to detect any effect, either.

In view of the above it appears that **neither in general, nor with respect to special programs like lean (in some of which man may well have a very essential role) can HRM practices be brought into relation with manufacturing firms' performance improvements.**

In the literature review section of the thesis, I repeatedly stated that the employee and HRM have critical roles in the lean system. What is more, with regard to lean systems Hines et al. (2004) regard the worker as the source of sustainable competitive advantage. Having conducted our analyses of the intensity and efficiency of use of HPWS practices, we are now in a position to opine, though only indirectly, on that matter. Presumably it is an indication of workers' critical role that the HPWS system was evaluated as more than moderately important in lean environments. And then again the fact that the intensity of use of HPWS practices has been stagnating for nearly two decades now raises doubts about workers' critical role and importance in sustaining a competitive advantage. A factor further weakening the argument is that on our sample of cross-sectional data, we failed to confirm HPWS practices' positive effect on lean manufacturers' performance. **All in all, however, the statement asserting the critical role of human resources is still acceptable, for lean manufacturers seem to require a certain level of the HPWS system to be present in order to be able to capitalize on the positive performance effect of lean's technical elements.**

7.4.3. Findings Concerning the Control Variables

Our analyses evince that several control variables have a significant effect (Table 7.12).

The group comparison shows that on our sample of lean manufacturers, the technical subsystem has a strong effect on operational performance. The strong effect of the technical subsystem could be detected despite the fact that our sample was already homogeneous with respect to the use of lean's technical elements. This may be an indication that in sorting out lean manufacturers, it might be worth for a subsequent research to opt for the three-cluster solution instead of the two-cluster variant I chose.

As the further columns of Table 7.12 evince, the group comparison indicates that the control variables that affect lean manufacturers' performance improvement differ by the manufacturing strategy goal pursued. As regards cost-oriented lean manufacturers, size has a negative, and the mass-orientation of the production process has a positive effect. The lean technical subsystem appears as an influencing factor (as was the case on the entire sample) irrespective of the manufacturing strategy goal pursued, though its effect is weaker and less significant. And finally, a good illustration of how much the effects may differ between the various subsamples is the customer service process. On the entire sample, the mass-orientation of the customer service process exhibited a positive effect (though only significant at the 0.1 level), whereas it is completely absent from the results pertaining to the individual manufacturing strategy goals.

Table 7.12. Effect of the control variables

Variable	**Explanation**	**Group comparison**			**Interaction effect**
		Lean manufact urers	**Cost-oriented**	**Quality- and flexibility-oriented**	
Size	# of employees (log)		- -		
Mass-orientation of production process	Mass producer =1; non-mass production= 0		+++		
Customer service process	„mass-like" needs =1; unique needs = 0	+			+
Technology	1 – manual, 5 – automated				
Lean technical subsystem	Averages of lean's technical elements	++++	++	++	+++

Notes: positive effect: ++++ p=0.000; +++ p=0.01, ++ p=0.05;+ p=0.1; - signs if effect is negative

The analysis of the interaction effect also underlines the impact of lean's technical subsystem.

According to our analysis of the control variables, it is the further enhancement of the technical subsystem that lean producers may primarily count on in improving their performance. Moreover, cost-oriented lean manufacturers would be well-advised to also pay attention to the effects arising from company size (negative) and the mass-orientation of the production process (positive).

7.4.4. Originality in the Literature Review

The literature review featured in this dissertation contributes to the Hungarian literature of modern Operations Management as well as, in certain regards, to the socio-technical literature on the lean production system.

The points at which it adds to the Hungarian literature are:

- The various modern production concepts are simultaneously present in the Hungarian literature. My thesis captures the novelty of the lean system in five items:
    - the lean system functions as an „umbrella" integrating the set of tools that TQM, JIT, TPM, TPS and, partly, AMT have already been using;
    - the system is not limited by the boundaries of the organization, but also affects, via the respective material flows, (internal) supplier and (internal) customer relations;
    - in addition to technical practices, Human Resource Management, as well, is a heavily emphasized (the most heavily emphasized among all the corporate functions) domain under the socio-technical approach;
    - instead of picking out just a couple of tools, it strives for program-wise, company-wide implementation;
    - puts emphasis on extending beyond the (mass) production environment and on organizational embeddedness, which is why many refer to it as a management system.
- Though implicitly, both the Hungarian literature and the portion of the international literature accessible from Hungary creates a link between the technical side of lean production and the reform of work organization, but no previous Hungarian study has ever attempted to provide a conceptual explanation. The present thesis relies on MacDuffie's (1995) organizational logic concept to demonstrate that in the lean system, changes in production go hand in hand with changes on the human resource side. This train of thought advocates that the domain where the worker's role is of the utmost importance is problem solving.

As part of the review of the international literature, my thesis discusses a number of focal points that Operations Management, too, should give more attention to:

- It relates the socio-technical lean system to organizational models. Drawing from Taira, it points out that MacDuffie's (1995) organizational logic concept describes a specific aspect of Aoki's (1990) J-mode organizational model: the relationship between production and HRM. In view of the organizational model, we may conclude that lean production is a (though maybe not the only) system that fits well to the changes observed in the environment, which however does not mean that it can provide an adequate response to every possible circumstance. Thus it would be worthwhile to consciously strive to establish links between organizational theories (or the models describing organizations' operation) and the changes occurring in Operations Management.

- With regard to the focal points of the socio-technical studies on lean production, it points out that
  - even though lean production did introduce novel (as compared to traditional mass production) methods into work organization, it still builds upon the Taylorian foundations, thus radically distancing ourselves from the latter seems unjustified.
  - even though in lean environments, employees' improved position is (without proof) attributed to HPWS practices, in fact it is not possible to draw up such a ranking among production systems. What is more, lean production may – especially in repetitive and labor-intensive environments – even affect employees negatively.
  - even though theoretically, a wide range of HPWS practices is associated with the lean system, Operations Management research has a tendency to discuss only a few of them. It does not make the picture any clearer, either, that the operationalization of HPWS practices is heterogeneous in the extreme, and that the focus of any given lean study significantly affects the operationalization of the lean system.
- Having reviewed the literature with the relationship between lean production and strategy in mind, we found that:
  - Operations Management research rarely if ever looks into the effect that strategic goals have on HRM practices (Santos 2000; Jayaram et al. 1999). Modern production systems are dealt with in a single study only (Youndt et al. 1996), whereas production strategy as

a contingency may have an important influence on any production concept, including the lean system.

- the related HRM papers can be assessed under three aspects:

    - either they are „earmarked” for examining the relationship between strategic objectives and HPWS practices, thus ignoring production (and all other functions) altogether (synthesizing approach),
    - or, if a modern production system does appear (e.g. quality management, TQM), then they practically equate it with the differentiation strategy and regard it as incompatible with cost-leadership,
    - the production function and production concepts (technologies) receive little attention in the HRM literature. Thus if Operations Management indeed believes that human resource is a critical factor – which, as we know, is certainly not the case the other way round –, then it is those on the production side who ought to be more active with respect to topics on the very borderline between the two fields.

7.5. Research Limitations

The limitations of my research are, for the most part, those that any international, multi-industry questionnaire survey has to reckon with.

Country- and industry-specific effects are ignored in the study. As I have already pointed out in the literature review, culture and national specifics may seriously influence the HRM system and the integrated socio-technical lean system. Earlier IMSS surveys established that country of origin may have an effect (possibly even larger in extent than that of industry) on production practices, as well (Demeter, Chikán, and Matyusz 2011). The investigation of effects specific to given countries and regions (or even cultural communities) appears to be a topic worth focusing on in future research.

The operationalization of the variables constitutes another limitation, as in the most cases, we could rely on one question per variable only.

The lean production techniques I used to define lean manufacturers corresponded to the variables identified on the basis of earlier socio-technical studies. The set of technical variables I relied on did not, however, include the practices related to the organization's supplier and customer relations. Using a more narrow set of internally oriented technical variables is not without precedent at all, but one must be aware that reducing the circle of variables may influence the results. It might be the case, for example, that cost-oriented lean manufacturers prioritize external relations in their lean transformation efforts – which, however, were not even considered in this study. Employing a broader set of the lean production system's technical variables would inevitably lead to more well-founded results.

In the operationalization of manufacturing strategy goals, I built upon a widely used variable set (competitive priorities in production). Owing to the taxonomy chosen, it was justified to reduce the research to two manufacturing strategy goals only. A manufacturing strategy interpretation different from the one applied in this thesis may easily lead to a different classification and, hence, differing results. An important limitation is that though the dissertation does presume a relationship between business strategy and manufacturing strategy (competitive priorities), this relationship is subjected to no scrutiny. This is a particularly important limitation because the HRM literature often employs the Porterian classification with respect to competitive strategies, but the indicators used to operationalize it are highly diverse. As discussed earlier, geographical location may even affect strategic goals, but I ignored this aspect, as well.

The dissertation involves a narrow set of HRM variables, namely MacDuffie's (1995) work organization bundle. The review of theoretical considerations pertaining to lean production and previous empirical works implies that several HRM practices of presumably critical importance were omitted. As for the future, the set of variables could be easily extended by slight modifications to the IMSS questionnaire and by improving the data quality of the survey. Data quality issues arose in regard to the questions that were not measured on Likert scales. A future program for investigating specifically the socio subsystem of the lean production system should take into consideration the following:

- to improve the reliability of the measurement, it is inevitable to have more than one variable describing any one HPWS practice,
- the operationalization of certain variables needs revision (e.g. the number of variables used to describe the individual practices is enormous and they differ from

study to study); it would seem reasonable to build upon widely acknowledged pieces of the HRM literature and thus more or less abandon the variables that Operations Management has been using – and hence lending legitimacy to – so far,

- HPWS practices that signify organizations' „reciprocity" should be involved in the analyses, as well,
- HRM practices should be evaluated from multiple perspectives, questionnaires now seeking responses from a single manager only (who is, to top it all off, the manager responsible for the production area and thus evaluating her/his own work) should be supplemented with employees'/workers' opinions.

The thesis analyses a wide range of operational performance indicators. The approach taken (i.e. merging variables into a principal component) constitutes a limitation insofar as the individual manufacturing strategy goals (e.g. the cost-oriented one) could not be linked to the respective performance items (e.g. unit manufacturing cost). It might be desirable for later research to find these links between manufacturing strategy goals and the operational performance indicators supporting them.

From amongst the many external and internal contingencies, my research focuses on manufacturing strategy goals only. Other factors affecting production practices and operational performance and frequently involved in related studies are technology, size and environmental effects (Matyusz 2012; Sousa and Voss 2008). These contingencies were represented by a mere control variable each, at best. A large-sample study on any one of these contingencies in a lean environment would have been a novelty, but it would also have distracted the present thesis from its focus. It makes the investigation of contingencies much more difficult (maybe even impossible?) that even though it is usually alluded to as an important research avenue with respect to best practices, it is hard to find well-accepted variable sets for the individual contingencies (e.g. manufacturing strategy goal, size, technology, environment). The difficulties experienced in setting up the appropriate analytical framework might urge the experts of contingencies and best practices to cooperate.

My research succeeded in demonstrating with respect to the lean production system that the intensity of use of lean production's practices differs according to the manufacturing strategy goal pursued. This is an important contrast indeed, yet other methodologies will need to be employed if we are to analyze the effects that manufacturing strategies have on the lean production system. One of the reasons this would be important is that, as Matyusz (2012) showed, customer expectations – as one of the contingencies – have hardly any influence on action programs (including the elements of the lean system) among manufacturing firms. At the same time, the lean management literature is teeming with allusions (e.g. beginning of Subchapter 6.2.4) to the firm's choice of action programs being somehow the resultant of influences from the business environment. Targeted research projects would be needed to explore the environment's impact on strategies, and to measure the environment's effect on the lean production system.

My use of the linear regression model constitutes a methodological limitation. The methodology being in widespread use with regard to best practices, I did not subject the assumptions justifying its use to critical scrutiny. It is possible, nonetheless, that the nature of the variables and the relationships thereof require a different approach (e.g. non-linear relationship). The task of investigating the matter is left for future research.

It is always wise to clarify what a given study cannot be expected to answer. I made no comparison between traditional and lean manufacturers. Thus we do not know which HRM practices accompany the different manufacturing strategy goals at traditional producers. Or whether there is a difference between the socio subsystems of lean and non-lean firms at all. Previous papers highlighted the significance of process choice, e.g. found that mass-oriented processes were usually accompanied by more intensive and efficient lean systems. The dissertation has not thoroughly discussed this issue, either. The sample created for our purposes is, nevertheless, well-suited for analyzing these problems.

Other, non-questionnaire-based methodologies may aid in interpreting the results. Tracking and recording in case studies the lean transformations of firms pursuing different strategic goals might be a good option. This might reveal the role of HRM in such transformations and how exactly it supports lean management.

It is imperative that at this point the reader be once again reminded that the dissertation primarily draws upon the Operations Management literature, and it is this branch of science, as well, that my findings are intended to contribute to. The conclusions of the thesis certainly must not be considered generally valid, considering that HRM experts may easily supplement – or possibly refute – the arguments I came up with. These conclusions do, nevertheless, draw a valid and reliable picture of how the representatives of Operations Management look upon HRM today.

8. Summary

The lean production system is a business practice that Operations Management research devotes special attention to. For the purposes of my thesis, the **lean production system was defined as a socio-technical system** that **is built upon the best practices of Operations Management and HRM (HPWS)**.

Mainstream lean research promotes the view that the application of the lean system leads to superior operational performance irrespective of the context. As a „consequence" of this context-independence, we know little about the effects of the various internal and external factors, even though numerous renowned researchers have urged the investigation of, for example, the relationship between manufacturing strategy and the lean production system. My research picks out one of the internal factors affecting the lean system, namely manufacturing strategy goals. My thesis **analyzes the relationships between manufacturing strategy goals and the socio subsystem of lean.**

Because of the small number of relevant studies, I decided to rely on the findings of multiple branches of science in elaborating my research questions and hypotheses.

The part of the **literature dealing with the technical subsystem** reflects, for the most part, the best practice perspective. Some of the empirical findings, nonetheless, indicate that manufacturing strategy decisions (process type) have a significant influence on the tools of the lean production system, providing evidence that **there is no uniform lean production system configuration**. The field of Operations Management does not, however, feature any empirical works dealing with either manufacturing strategy goals, or the socio subsystem.

The overview of the best fit and the synthesizing approaches contributed greatly to outlining the relationship between strategic goals (competitive capabilities) and the socio subsystem. Both approaches suggest that competitive capabilities have a significant impact on HRM: **they associate HPWS practices with the differentiation strategy,** and at the same time **anticipate cost-leaders to make less intensive and less efficient use of HPWS practices**. Based on these two approaches, it might be assumed that lean production's socio subsystem differs by manufacturing strategy goal.

After having identified the content of manufacturing strategy goals, my study proceeds to work on the assumption that there is a significant difference in the intensity of use and the contribution to operational performance of HPWS practices between cost-oriented, and quality- and flexibility-oriented lean manufacturers.

One of my important findings is related to the identification of the content of manufacturing strategy goals: **by the late 2000s, the cost-oriented manufacturing strategy goal has gained ground among large manufacturing firms,** and **differentiators put emphasis on variety, swiftness and services**.

My results evince that the configuration of the lean production system differs by manufacturing strategy goal. Contrary to my expectations, **the two groups – pursuing different manufacturing strategy goals – exhibit similar intensity in the use of HPWS practices** (rejection of Hypothesis 1). In line with previous findings, it is in the technical subsystem that my analyses detected dissimilarities: quality- and flexibility-oriented lean manufacturers are ahead in terms of implementing lean's technical elements.

My analyses failed to confirm Hypothesis 2 (moderating effect), as well. That is, not only is a difference between the two groups in the efficiency of use of HPWS practices missing, but **HPWS practices have no role in improving operational performance with respect to either manufacturing performance goal**.

The generalizability of my findings is diminished by the fact that I only considered lean production techniques related to internal processes, and that it was only a reduced circle of HPWS practices, too, that I could involve in the analyses.

In spite of the above, my results suggest that the HPWS practices considered do have an important role at large manufacturing firms, for their presence was measured to be above the average. Which indicates that by now, **HPWS has become a standard set of practices that functions as a qualifying criterion with respect to this segment of businesses**. That is to say, firms can deliver superior performance only if they have well-qualified, multi-skilled employees capable of working in teams and taking part in improvements. Yet as of today, not even such firms can rely on HPWS practices to improve their performance. The path to capitalizing on the potential of HPWS practices probably leads through the full exploitation of the capability of technical elements to improve performance and the further strengthening of HRM.

HPWS's currency among large manufacturing firms leads us to labor market and training related issues. Winning large manufacturers and developing the supplier network requires a labor market and an education environment that support the laying of the foundations of HPWS practices and the development of human resources in accordance with the ever-changing circumstances. It seems a reasonable expectation that the public education system should provide for the development of basic competencies (not necessarily professional skills). Firms' unique needs in terms of skills, and the swift and flexible adaptation to changing circumstances can, however, be ensured only by means of an institutional framework that promotes decentralized solutions, e.g. subsidies, local cooperations, close coordination with the vocational training system. It is not only the lean system that may benefit from investments into human resources as the very foundations of organizational innovation, but it may as well contribute to economic competitiveness in general.

It is not only the regulatory environment that is in a position to contribute to the development of human resources. Firms, as well, need to put greater emphasis on better HRM (non-administrative tasks) and on tracking the needs of the production system.

The expertise of Operations Management professionals, including lean experts, could and should be tapped into so as to support the formulation and implementation of education and development policy goals, and to ensure that firms attribute to HRM the value and importance that it deserves. A further mission for lean management experts is to make production and logistics professionals (future generations included) aware that the lean system is not a bunch of production tools. Conceptual frameworks will need to be developed in order to present in an easily comprehensible way the complexity of the lean production system (e.g. role of human resources, organizational culture, supplier management) and to recommend specific action program sequences in the areas defined as being part of the system. Such action could serve to avoid short-term-focused lean workshop series, which by no means promote the full implementation of the system.

My research questions were formulated on the basis of a comprehensive review of the literature, yet the examination of even the most scientifically well-founded questions entails certain risks when fashionable management systems are concerned. Snell and Dean (1996) draw attention to an effect of the best practice approach that is impossible to investigate and yet has a substantial influence on research findings: **one would be well-advised to keep in mind that owing to the alleged context-independence „advertised" by advocates of the lean system, and to the resulting „implementation pressure", business practice has an inclination to not contemplate any external or internal influencing factors, irrespective of the circumstances**.

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Appendix 1 (Human Resource Management in the Best Fit Approach)

Author(s)		Miles and Snow (1984, p. 49)	Schuler and Jackson (1987)	Arthur (1992, p. 491)	Legge (2006, p. 224)
HRM practices/policies corresponding with strategic goals	**Cost**	*Defenders* Basic strategy – Building human resources Recruitment, selection and placement – Emphasis: „make”, little recruiting above entry level, selection based on weeding out undesirable employees Staff planning – Formal, extensive Training and development – Skill building, extensive training programs Performance appraisal – Process-oriented procedure (e.g. based on critical incidents or production targets), identification of training needs, individual/group performance evaluations, time-series comparisons Compensation – Oriented towards position in organization hierarchy, internal consistency, total compensation heavily oriented toward cash and driven by superior/subordinate differentials	*Low-cost producer (drawing from Porter)* *These practices maximize efficiency by providing management with tools for tracking and controlling employees' activities* - relatively stable and clear-cut job descriptions that can hardly be misinterpreted - narrowly defined jobs; narrowly defined career paths, which are also meant to support specialization, proficiency and efficiency - performance evaluation system centered around short-term results - monitoring wage levels in the market to aid in determining compensation scheme - minimum level of employee training and development	*Cost-reduction* - job tasks narrowly defined - very little employee influence over „management” decisions - no formal employee complaint/grievance mechanisms - little communication/socialization efforts - low skill requirements - intense supervision/control - limited training efforts - limited benefits - relatively low wages - incentive-based	*Hard model (Michigan)* *Treats employees as a variable input and minimizes related costs*

	Quality	*Prospectors* Basic strategy – Acquiring human resources Recruitment, selection and placement – Emphasis: „buy”, sophisticated recruiting at all levels, selection may involve pre-employment psychological testing Staff planning – Informal, limited Training and development – Skill identification and acquisition Performance appraisal – Results-oriented procedure (e.g. management by objectives or profit targets), identification of staffing needs, division/corporate performance evaluations, cross-sectional comparisons (e.g. other companies during same period) Compensation – Oriented toward performance, external competitiveness, total compensation heavily oriented toward incentives and driven by recruitment needs	*Quality-enhancer (drawing from Porter)* - relatively stable and explicit job descriptions - extensive employee participation in decisions that affect the immediate working environment or the job itself - the performance evaluation system is a combination of individual and group elements, most of which focus on the short-term and on results - employees treated equally (in comparison), employment security guaranteed to a certain degree - extensive and continuous training and development of employees	*Commitment-maximizing* - broadly defined jobs - high level of employee participation/involvement - formal dispute resolution procedures - regularly share business/economic information with employees - high percent of skilled workers - self-managing teams - more extensive, general skills training - more extensive benefits - relatively high wages - all salaried/stock ownership	*Soft model (Harvard)* *Treats employees as valuable resources* - careful recruitment and selection, emphasis on competencies - extensive use of communication systems - teamwork with flexible job planning - stress on training, learning and knowledge management - delegate responsibility by involvement in decision making (empowerment) - compensation partially contingent on performance

Appendix 2 (Data Cleaning)

	Variables (number of question) (measurement)	1. Data entry accurate	2. Missing data % (pieces) (N=725)**	3. Outliers	4. Little's MCAR test (filtered using 'if' condition)	5. Analysis of observational units' responses	Missing data % (pieces) (N=409)	Analysis of missing data on cleaned database
Production	Process focus (PC4b) *	yes, no values other than 1 to 5	1.52% (11)	none	Chi-square=15.250 Sig. = 0.292	no response to at least two questions (out of the four): BE2, BE14, BE27, CN10, CN47, CN52, IT5, IT46, IT52, JP12, JP18, KR16, NL20, PT5, RO20, RO25, RO28, RO31, UK6, UK17, UK28, US5, US10, US44,	0% (0)	Chi-square=5.364 Sig. = 0.802
	Pull production (PC4c) *		2.07% (15)				0.5% (2)	
	Quality improvement (Q2a) *		2.62% (19)				0.2% (1)	
	TPM program (Q2b) *		2.90% (21)				0.2% (1)	
Human Resource	Organizational levels (O1) (# of)	not possible to assess	4.55% (33)	**9 or more levels qualify as an outlier (15)**	Chi-square=69.626 Sig. = 0.210	no response to at least three questions (out of the nine): CN36, GE2, GE13, IT2, IT13, IT53, JP9, JP11, JP, 12, JP18, JP25, NL20, RO11, RO20, RO25, SP7, SW14, TW8, UK6, UK10, UK12, UK16, UK25, US14, two missing: CA12, CN47, DK1, EE15, EE18, GE4, GE26, HU34, HU60, IT12, IT30, IT52, JP13, JP19, JP22, JP28, KR16, KR29, MX12, MX13, MX15, NL44, PT4, PT5, RO1, RO10, RO28, SP40, TW3) Outliers with respect to training and organizational levels on the next page.	2.9% (12)	Chi-square=92.290 Sig. = 0.644
	Proportion of incentives (O4a) (%)	Many values missing from the responses themselves, for the Dummy variables (O4b1-O4b3) contain missing value/1 pairs instead of 0/1 pairs, these were corrected; accurate, because if wherever there is a value, it is 1	16.28% (118)	none, omitted due to missing data (more than 35% would have qualified as outliers (560))				
	Work group incentive (O4b1) (dummy)		171 (23.59%) firms did not report either one. Unfortunately it is impossible to know whether indeed absent or failed to report. Response rate of O4a considered authoritative.	none, omitted due to missing data				
	Individual incentive (O4b2) (dummy)							
	Companywide incentive (O4b3) (dummy)							
	Involved in process development (O5) *	yes	3.03% (22)	none			2.2% (9)	
	Continuous improvement (O11c) *	yes	2.34% (17)	none			1% (4)	
	Functional groups (O6a) (%)	none of the sum totals above 100%	13.93% (101)	assess normality			9.3% (38)	

	Cross-functional teams (O6b) (%)	none of the sum totals above 100%	21.24% (154)	omitted due to missing data				
	Training (O7) (hours/employee)	not possible to assess	10.07% (73)	**80 hours/employee qualify as an outlier (38)**			6.1% (25)	
	% of annual sales on training (A6c) (% of annual sales)	none of the sum totals above 100%	20.00% (145)	omitted due to missing data				
	Multiskilled workers (O8) (% of production workers)	none of the sum totals above 100%	4.41% (32)	assess normality			1.2% (5)	
	Rotation (O9) *	yes, no values other than 1 to 5	1.24% (9)	none			0.5% (2)	
	Autonomy (O10) *		1.52% (11)	none			0% (0)	
	Delegation (O11a) *		1.66% (12)	something is wrong with the value of 4!!!!			0.2% (1)	
Operational performance	Manufacturing conformance (B10aa) *	yes, no values other than 1 to 5	6.62% (48)		Chi-square=158,184 Sig. = 0,094	no response to at least three questions (out of the ten): BE14, BE16, BE33, BR4, BR18, BR26, BR34, BR36, CA14, CN1, CN17, CN19, CN36, CN42, CN43, CN46, CN47, EE16, GE15, HU19, HU20, HU28, HU59, IT5, IT54, JP12, JP13, JP19, JP20, JP22, MX12, NL17, NL20, NL31, NL36, PT5, RO4, RO19, RO25, RO28, SP7, SP10, SP22, UK2, UK6, UK28, UK30, US10, US20, at least two: BE17, BE35, CN30, CN49, IT22, IT52, IT53, JP28, NL27,	1.7% (7)	*Chi-square=151.612 Sig. = 0.031*
	Product quality and reliability (B10ba) *		5.66% (41)				0.5% (2)	
	Volume flexibility (B10da) *		7.31% (53)				0.2% (1)	
	Mix flexibility (B10ea) *		7.45% (54)				1.2% (5)	
	Unit manufacturing cost (B10ka) *		6.90% (50)				0.2% (1)	
	Delivery speed (B10ia) *		6.76% (49)				1% (4)	
	Delivery reliability (B10ja) *		6.34% (46)				0.2% (1)	
	Manufacturing lead time (B10ma) *		6.48% (47)				0.2% (1)	
	Inventory turnover (B10pa) *		7.86% (57)				1% (4)	
	Labor productivity (B10oa) *		6.90% (50)				1% (4)	

Strategic goals	Lower selling prices (A4a) *	yes, no values other than 1 to 5	1.52% (11)		Chi-square=84,807 Sig. = 0,394	no response to at least three questions (out of the nine): BR25, CN8, CN37, GE23, HU8, HU34, IT5, IT28, IT31, IT32, MX15, RO20, Ro25, RO28, SW30, UK6, UK16, (two missing: HU45, HU63)	1.2% (5)	Chi-square=99.828 Sig. = 0.374
	Superior conformance to customer expectations (A4c) *		1.79% (13)				1.5% (6)	
	Superior product design and quality (A4b) *		1.52% (11)				1.2 (5)	
	Faster deliveries (A4e) *		1.52% (11)				1.2% (5)	
	More dependable deliveries (A4d) *		2.34% (17)				2.4% (10)	
	Superior customer service (A4f) *		2.34% (17)				2.2% (9)	
	Offer new products more frequently (A4h)*		2.90% (21)				3.4% (14)	
	Greater order size flexibility (A4j) *		2.62% (19)				2.9% (12)	
	Wider product range (A4g) *		2.62% (19)				2.7% (11)	
Control variables	# of employees (A1c) (persons)	not possible to assess	1.38% (10)	**100 people =< Size <= 2000 people (485)**	These data are not logically related, and therefore I deemed the test superfluous.	see table on next page	0% (0)	These data are not logically related, and therefore I deemed the test superfluous.
	Process type (B8) (%)	none of the sum totals above 100%	2.76% (20)	none		BE4, CN58, MX17 ***	0.7% (3)	
	Customer order type (B9) (%)	none of the sum totals above 100%	3.31% (24)	outliers are present, yet no specific proportion is conceptually justified to be designated as a limit		BR11, CN20, CN58, HU70, MX17, NL28***	1.5% (6)	
	Technology (T1a) *	yes, no values other than 1 to 5	2.84% (18)			GE1, EE27, IT56, SW12, NL1***	1.2% (5)	

* 5-point Likert scale
**only those variables were removed from the database at first where at least 15% of the data were missing. This enabled some key variables to remain in the sample, which in the final sample already exhibited missing value percentages below 10%.
***were removed from the sample in the last phase

Question	Outlier	Number of observational unit (value of the variable for the given observational unit)		
Organizational levels (O1) (# of)	9 or more	CN54 (50), CN59 (20), JP6 (10), KR10 (99), KR11 (10), RO7 (10), RO8 (10), RO17 (10), TW11 (11), UK7 (12), UK11 (32), US2 (9)		
Training (O7) (hours/employee)	more than 80 hours/employee	BE5 (100), BE13 (100), BR8 (250), BR9 (100), BR10 (89), BR19 (209), BR22 (1300), CN11 (98), CN14 (300), CN23 (240), CN30 (288), CN32 (96), CN34 (100), CN41 (100), EE12 (100), GE24 (175), IRL2 (200), IT36 (100), IT51 (100), JP4 (120), JP24 (100), KR23 (100), KR24 (100), KR38 (100), MX5 (100), MX11 (90), PT1 (110), TW14 (96), TW20 (100), TW24 (96), UK4 (100), UK7 (100), US32 (100), US33 (100)		
# of employees (company and its number)	none, less than 100 people, more than 2000 people	Less than 100 people: CA17, CA18, CN21, CN25, CN27, CN48, CN54, CN57, DK6, DK10, EE02, EE04, EE06, EE07, EE11, EE14, EE15, EE18, EE19, EE20, EE23, EE25, EE26, GE8, GE22, GE34, HU15, HU25, HU29, HU35, HU46, HU48, HU49, HU51, HU54, HU57, HU58, HU65, IT3, IT15, IT35, IT41, IT55, JP21, KR1, KR2, KR3, KR5, KR6, KR8, KR9, KR10, KR12, KR13, KR14, KR15, KR17, KR18, KR19, KR20, KR22, KR23, KR26, KR27, KR29, KR30, KR32, KR33, KR35, KR37, Kr38, KR39, KR40, KR41, MX3, MX4, NL2, NL6, NL7, NL8, NL11, NL14, NL18, NL30, NL35, NL38, NL42, NL45, NL47, RO3, RO8, RO13, RO18, RO21, RO23, SP1, SP13, SP18, SP40, SW8, SW11, SW16, SW26, TW1, TW2, TW3, TW4, TW6, TW7, TW20, TW21, UK3, UK5, UK8, UK11, UK14, Uk15, UK20, UK21, UK23, UK24, US9, US18, US22, US26, US30, US32, US39, US43,	more than 2000: BE6, BE7, BE9, BE25, BE36, BR6, BR7, BR20, BR33, BR35, CN2, CN4, CN24, CN38, CN39, CN41, CN45, DK4, DK5, EE08, EE24, GE3, GE6, GE9, GE11, GE27, GE33, HU12, HU24, IRL2, IRL3, IRL5, IT12, IT32, JP2, JP7, JP8, JP26, JP28, MX2, MX8, MX16, NL22, NL43, NL48, PT4, RO1, SP12, SP25, SP37, SP39, SW1, SW5, SW17, SW23, TW11, TW12, TW14, TW23, TW24, TW25, TW28, UK27, US1, US2, US12, US15, US38, US40, US42, US45	unknown: CN5, IRL1, KR4, MX1, MX7, MX13, NL10,