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Short running title: Manufacturing in subsidiary types

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Abstract

In the last decades several companies have become manufacturing networks of plants, operating usually in an international context. These plants can serve different purposes and have different levels of competences. This diversity influences the use and effectiveness of different manufacturing practices, which has not yet been explored in the literature. This paper investigates the relationship between plant roles and the "goodness" of manufacturing practices using a sample of 471 plants from the sixth edition of the International Manufacturing Strategy Survey. The findings show that plants with higher competence have more best practices than less competent plants. Furthermore, more competent plants usually strengthen their differentiation performance, while less competent plants focus on and achieve cost performance improvements instead.

Keywords: Multinational companies, Subsidiary role, Performance, Manufacturing practices, Manufacturing network

Introduction

Several practical examples in the literature show that multinational companies today operate international manufacturing networks (IMNs) spreading all over the world, with different manufacturing plants playing different roles within the network. There is also an impressive body of literature about the use of manufacturing practices in single plants and their impact on performance, referring to the most effective ones as best practices. *The question addressed in the paper is whether the "goodness" of manufacturing practices depends on the role a plant plays in an IMN.*

Since Ferdows' seminal article (1997) on plant roles, many papers have been published on this topic in operations management literature. As Ferdows argues, sites can improve their competences by building up knowledge not only in the field of production, but also in purchasing, distribution, customer relationships, and innovation, thereby developing themselves toward "higher" roles. Although Ferdows' original article contains only examples, several papers operationalized his work through case studies (Vereecke and Van Dierdonck, 2002; Miltenburg, 2009; Cheng, 2011; Cheng et al., 2011) and surveys (Feldmann et al., 2009; Turkulainen and Blomqvist, 2011), and basically found the framework to be valid. What these papers did not do, however, is look at the manufacturing practices these plants use and their performance outcomes.

Furthermore, there are some papers that explore the impact of national context on the use of manufacturing practices (e.g. Cagliano et al., 2001; Oliver et al., 1996; Vastag and Whybark, 1991; Voss and Blackmon, 1996). However, none of them investigates the impact of the role these plants play within their IMNs. Following these two observations we investigate the extent to which plant role affects the goodness of various manufacturing practices in terms of their performance implications.

First we summarize the literature on plant roles and manufacturing best practices. Then we introduce the database and the research methodology. Next, we analyze the data and present and discuss our findings. Finally we draw some preliminary conclusions.

Literature review

Plant roles: strategic reasons and competences

Both plant roles and best practices have been extensively researched in the last decades.

Ferdows (1997) was the first to develop a typology going more deeply into value creating activities within plants and using the perspective of plants instead of the whole network. He identified three strategic reasons for choosing a specific site: a) access to low-cost production, b) access to skills and knowledge, and c) proximity to the market. Vereecke and Van Dierdonck (2002) identified nine potential strategic reasons from the literature but, exploring an interview-based sample of 59 companies, they concluded that the main location drivers identified by Ferdows (1997) are by far the most important ones.

Ferdows (1997) determined the level of site competence as well. Along the strategic reasons and site competences, plants can position themselves in six different roles (the list in Table 1 is ordered from lowest to highest level of competences). As Ferdows argues, sites can improve their competences, especially by building up knowledge not only in the field of production, but also in purchasing, distribution, customer relationships (altogether in supply chain management), and product/process development, thereby developing themselves toward "higher" roles. Competence development and roles depend on managerial aspirations as well as on country level factors. Ferdows does not define a strict relationship between strategic reasons and competences.

Competences were in the center of analysis in Feldmann et al. (2013). They found three basic bundles of competences that plants can develop: a) *production competence,* including process improvement, technical maintenance and production, b) *supply chain competence*, comprising supplier development, procurement and logistics, and c) *development competence*, consisting of the introduction of new product technologies, product improvement and introduction of new process technologies. According to these authors, competences are cumulative: plants with supply chain competences already have production competence, and development competence is built on production and supply chain competence.

Turkulainen and Blomqvist (2011) identified three clusters of 101 Finnish companies based on their level of competences. They used two additional competences compared to Feldmann et al. (2013):

production planning and supplying global markets. Based on factor analysis of potential competences they identified a fourth competence bundle as compared to Feldmann et al. (2013) by splitting production competence into process and manufacturing competences. The former contains process improvement and technical maintenance, while the latter incorporates production planning beside production. Process and production competence values are very similar in each cluster, so their separation does not add too much value. The second additional competence, supplying global markets, belongs to the development competence bundle. Both Vereecke and Van Dierdonck (2002) and Turkulainen and Blomqvist (2011) mention that even if some plants were established in order to serve markets, through time they became a hub of knowledge, practically reaching the competence level of lead plants.

Based on these findings we can build an intuitive relationship between plant roles, their strategic location reasons and competences as presented in Table 1. According to Ferdows (1997) the last three plant roles possess more advanced competences compared to the first three groups.

Insert Table 1 here

Best practices

According to Voss (1995) best practices are one of the alternative paradigms of manufacturing strategy. “The underlying assumption of this paradigm is that best (world class) practice will lead to superior performance and capability. This in turn will lead to increased competitiveness” (Voss, 1995:10). Laugen et al. (2005) suggest that best practices are what the best performing companies do, that is, companies with the best performance improvement results. Davies and Kochhar (2002) also suggest that best practices are those leading to significant improvement of performance.

Best practices change over time and are context dependent. Using an international survey, Laugen et al. (2005) found that quality management and ICT lost their best practice status in early 2000 to lean management techniques such as process focus, pull production and equipment productivity, plus environmental compatibility. They also indicated e-business, new product development, supplier strategy and outsourcing as potential best practices in the future. And indeed, some years later Laugen et al. (2011)

identified four best practices: lean manufacturing, supply chain management, new product development and servitization.

In fact, these four practices are bundles or sets of practices, usually grouped based on conceptual, theoretical, or empirical considerations. For example, lean management consists of four broad practice bundles of just-in-time, total quality management, total preventive maintenance and human resources management (Shah and Ward, 2003), and each of these broad bundles can be further broken down into practices and tools. Voss (2005) argues that it is more straightforward to look at bundles of practices instead of just single practices, as single practices complement and sometimes substitute each other addressing the same problems in a company.

Boer et al. (2013) also use the ‘bundles of best practices’ approach. They analyzed if the four bundles identified by Laugen (2011) are best practices everywhere looking at home and host country effects. They concluded that, while lean manufacturing, supply chain management and servitization are best practices in plants where country of origin and country of location are at the same level of development (both countries are either more developed or less developed), new product development is a best practice only in plants where a parent company from a more developed country established a plant in a less developed one.

Laugen et al. (2011) controlled for company size and production process type, Boer et al. (2013) for country context, but none of them for plant type. Thus, it is not clear whether the practices identified above are best for all types of plants.

This paper is based on the proposition that, due to the diversity of roles a manufacturing plant can play in a manufacturing network, best practices also depend on the role that plants fulfill. The “higher” a plant’s role, the higher the competence it has and, in effect, the plant has better process and product knowledge and more developed skills in implementing manufacturing practices. Thus, we expect that plants with higher competences implement practices more successfully, resulting in higher performance. In other words, we expect that plant role moderates the relationship between potential best bundles of operations practices and operations performance improvement, as depicted in Figure 1.

Inert Figure 1 here

Research methodology

Research sample

Plant roles within IMNs, as well as manufacturing practices and performance are measured using data from the sixth round of the International Manufacturing Strategy Survey (IMSS VI). The IMSS is carried out by an international network of researchers focusing on the manufacturing strategies, practices and performances of manufacturing plants from all around the world (www.manufacturingstrategy.net). IMSS VI was carried out in 2013-2014 and includes responses from 22 different countries, including 3 countries from the Central-Eastern European (CEE) region. The data collection process was administered in each country by local coordinators. Wherever needed, English language questionnaires were translated into local language by manufacturing strategy academics using a reliable method (double and/or reverse translation). Targeted plants were chosen from official databases of manufacturing organizations in each country, belonging to the ISIC Rev. 4 Divisions 28-35 (manufacture of fabricated metal products, machinery and equipment). The questionnaire was filled in by Manufacturing/Operations Managers. While the questionnaire also included some contextual business unit level data on competitive position, the unit of analysis is the manufacturing plant,. The IMSS VI database contains data collected from 931 manufacturing plants. Despite the large overall sample size an important drawback of the data employed is that individual country samples are not statistically representative. However, the relatively high number of respondents and the diversity of countries enabled us to search for general relationships and tendencies connected to manufacturing plants in an international context.

To define our research sample, we first selected manufacturing plants that are members of a manufacturing network consisting of multiple plants within the same company. The IMSS VI questionnaire enquired about whether the manufacturing plant is a stand-alone plant (being the only plant that belongs to the company) or part of a domestic, regional or global manufacturing network. Furthermore, we filtered out all respondents that provided insufficient data on plant typology, manufacturing practices or performance. The final research sample consists of 471 plants identified as manufacturing network members, which represents 50.6% of the total sample. The composition of the final sample by country/region, size and industry is presented in Table 2 and Table 3.

Insert Table 2 here

Insert Table 3 here

Measurement of practices and performance

Confirmatory factor analysis (CFA) was used to develop manufacturing practice bundles and performance improvement indicators.

Altogether 19 individual items were used to develop manufacturing practice bundles: the respondents had to indicate the effort put in the last three years into implementing action programs connected to manufacturing and supply chain operations (1-5 Likert scale: 1="None", 5="High"). Four internal manufacturing and two supply chain related practice bundles were developed: advanced manufacturing technology (*Tech*), quality management (*Qual*), lean production (*Lean*), human resource management (*HR*), supplier integration (*SuppInt*), and customer integration (*CustInt*). CFA details are presented in Appendix 1.

Nine questionnaire items asked respondents to indicate how their manufacturing performance had changed over the last three years. These items conform to the definition of best practices in the literature (Davies and Kochhar, 2002; Laugen et al., 2005) according to which practices are "best" if they lead to an improvement in operational performance. Performance improvement was measured on a 5-point scale: 1="Decrease (-5% or worse)", 2= "Stayed about the same (-5%/+5%)", 3= "Slightly increased (+5/+15%)", 4= "Increased (+15/+25%)", 5= "Strongly increased (+25% or better)". For items where lower values represent better performance (e.g. cost, lead time) a reverse scale was used. Altogether, two performance improvement constructs were developed, following the logic of Porter's (1985) two main sources of competitive advantage (cost and differentiation): a first-order construct measuring cost performance (*CostPerf*), and a second-order construct of differentiation performance (*DiffPerf*) reflected in the first-order constructs of quality, flexibility and delivery related performance improvement.

Appendix 1 presents each practice and performance construct in detail, including descriptive statistics and path loadings. The absolute and incremental fit indices demonstrate construct validity, indicating that the measurement model shows good fit to the data.

The convergent and discriminant validity of the measurement model were also assessed. Convergent validity refers to the extent to which items of the same construct are related and share a high proportion of variance. Factor loadings, average variance extracted (AVE) and construct reliability (CR) were examined to assess convergent validity (Hair et al. 2010). At a minimum, all factor loadings should be significant. Additionally, all factor loadings must exceed .50, and ideally .70. In our case all standardized factor loadings are highly significant and – except for four items – all loadings exceed .70. Each of the four items previously mentioned have a path loading higher than .60, thus being well above the minimum threshold. The AVE values, computed as the mean variance of the items loading on the same construct exceed the usual threshold of .50 for both constructs. The CR values of both constructs, assessed using a threshold value of .70, show good reliability, indicating that individual items consistently represent the same construct.

Discriminant validity refers to the extent to which a construct is truly different from other constructs, and can be assessed by comparing the square root of AVE to the correlation between constructs (Hair et al. 2010). All correlation factors are lower than the square root of AVE of the constructs involved, thus indicating adequate discriminant validity. Detailed assessment of convergent and discriminant validity is presented in Table 4. The square root of the AVE measure for each construct is presented in the diagonal of the table, the rest of the items representing the correlation between each pair of constructs.

Insert Table 4 here

Control variables

To assess the goodness of manufacturing practices we investigate their impact on performance improvement controlling for three other variables. The first control variable introduced in our model is the level of economic development of the country of location, which has been reported to have an influence on the performance impact of manufacturing practices (Boer et al., 2013). Country-level economic development is assessed using the Global Competitiveness Index (GCI) computed by the World Economic Forum in its Global Competitiveness Report published on a yearly basis (Schwab, 2014). The 2014-2015 report is one of the most comprehensive studies in the field of measuring the competitiveness of countries, providing information on the level of economic development of 144 countries worldwide, including all countries involved in our research.

The second control variable is plant size, measured as the natural logarithm of the total number of employees. Size is one of the most important contingency factors, and is frequently used as a control variable in operations management studies (Sousa and Voss, 2008).

Finally, plant age is also introduced as a control variable measured as the number of years between the year of plant foundation and 2014. Developing a plant to a "higher" role takes time and has indeed been suggested to have an impact on the practices used by the plant (Vereecke et al., 2006).

Development of plant types

To identify different plant roles within manufacturing networks, two variables were used. First, the respondents were asked to indicate on a 1-5 Likert scale to what extent their plant is responsible for the three basic competence categories (production, supply chain, and development), complemented with the extent of being a hub for product/process knowledge (1= "No responsibility", 5= "Full responsibility"). Second, the respondents also had to indicate to what extent the three main advantages apply to the location of their plant: access to low cost resources, proximity to the market, and access to knowledge and skills (1= "Strongly disagree", 5= "Strongly agree"). To better grasp how important the local market is for a plant, the geographic area/market served by the plant was also added to the list of location factors (1= "Surrounding area/market", 5= "The whole world/global market"). The first variable (plant responsibilities) is derived from the work of Feldman et al. (2013), Vereecke and Van Dierdonck (2002), and Turkulainen and Blomqvist (2011). The second group of variables (location advantages, target market) corresponds to the possible advantages identified by Ferdows (1997), including the variable introduced by Turkulainen and Blomqvist (2011). Using hierarchical cluster analysis with Ward's method, and subsequent k-means cluster analyses, the following five plant types (Ferdows, 1997) were identified in our sample: 1) Lead (N=109), 2) Contributor (N=83), 3) Source (N=124), 4) Offshore (N=78), and 5) Server/ Outpost (N=77). The values of the two clustering variables for each cluster are shown in Figure 2.

The first three clusters (red, dark blue and light blue lines in Figure 2, left-hand side) have clearly higher competences than the other two clusters. Among the three high competence clusters, the red group has the highest competences, clearly focuses on the access to knowledge and skills, and is highly globally oriented at the same time (Figure 2, right-hand side). Thus, this group clearly represents "Lead" plants, which are the most important knowledge hubs within manufacturing networks. The dark blue group has the highest low cost orientation, and – although other location factors are equally important to them – they are clearly export oriented, pointing towards the characteristics of the "Source" plant. The highest location advantage of the light blue group is its proximity to the local market, and is by far the least globally oriented. Thus, based on the Ferdows (1997) typology, this cluster was termed "Contributor".

The two remaining clusters have lower competencies. The main difference is that the purple cluster distinctively focuses on production (Figure 2, left-hand side), has an important low cost motivation, and is highly export oriented, which altogether point towards the characteristics of an "Offshore" plant. The cluster marked with a green line has the lowest overall competences, and does not show high inclination towards any strategic location advantage. However, they are somewhat more inclined to serve local markets. As, altogether, this cluster seems to represent a mix of the characteristics of the "Server" and "Outpost" plant, we call them "Server/Outpost" plants. This is also in line with the literature: "*an outpost factory's primary role is to collect information […]. Because every factory obviously must make products […], virtually all outpost factories have a secondary strategic role – as a server or an offshore, for example*" (Ferdows, 1997: 76).

Insert Figure 2 here

To explore the distribution of plant types within the Central-Eastern European (CEE) region, we further explored the CEE section of our research sample, and compared it to the Western European (WE) region. Using z-tests we also investigated whether the percentage share of a particular plant type differs significantly between the two regions. The Z-test results, reported in Table 5, clearly indicate that the plant types (Offshore, Server/Outpost) with lower competence levels are significantly more prevalent in CEE than in WE. Notably, the percentage share of Offshore plants shows a large difference between the two regions (38.5% vs. 17.6%). Another important difference is in the share of Lead plants, which are much more frequent in WE than in CEE. The other two high competence clusters (Source, Contributor), however, show no significant difference.

Insert Table 5 here

Preliminary findings and discussion

Using the clusters and variables developed, separate multiple regression analyses were carried out for each cluster and each performance factor, with bundles of different manufacturing practices as predictor variables. Plant size (*Size*), plant age (*Age*), and the economic development of the country of location (*Develop*) were used as control variables in each model. Detailed results are presented in Table 6 and Table 7, and are summarized in Figure 3.

Insert Table 6 here

Insert Table 7 here

Insert Figure 3 here

A general observation

Looking at different plants on the vertical axis of Figure 3, the results indicate that the higher competence plants (Lead, Source, Contributor) implement a multitude of practices successfully and improve mainly their differentiation performance. Lower competence plants (Offshore, Server/Outpost), on the other hand, implement fewer practices successfully, and generally improve their cost performance.

Performance effects: a practice perspective

Advanced technologies are expensive, thereby – not surprisingly – they do not have positive impact on cost performance. However, they can increase differentiation performance irrespective of the strategic location factor of the plant, but only in case of more competent production sites – Lead, Source, and Contributor. Considering the development path of plants, this is also logical. First, new plants start to use established and reliable technologies to produce simple products. As soon as their competence level increases, they become capable to produce a higher variety of more complex products, for which the use of advanced technologies starts to pay off.

Quality management, a best practice in the 1980s and 1990s, has lost that status in the course of the 2000s (Laugen et al., 2005) to become a qualifying practice, which any company needs to have in place in order to be regarded as a potential supplier in the first place. In all cases, except for the differentiation performance of Server/Outpost plants, the performance effects are negative. In one case, the cost performance of Offshore plants, that effect is significant. We found two possible reasons for the negative relationship. On the one hand, employees in these plants are still less competent, so these plants have high quality cost due to higher level of failures, which is more expensive than prevention (Crosby, 1979). On the other hand, employees have low wages, and they are willing to change workplace for a minor wage increase. Therefore, employee fluctuation is high and companies have to spend considerable amounts of money for training new employees.

Lean management does not help reduce costs – lean only has a positive impact on differentiation performance (i.e., quality, delivery, flexibility) and, then, only for Lead and Source plants. This is an important implication for companies engaged in lean implementation programs. The issues of ineffective attempts to directly reduce costs (not just in case of lean implementation) are discussed in Matyusz et al. (2012).

Human resource (HR) development practices have a positive influence on differentiation performance for all types of plants, except Server/Outpost plants, and a cost performance effect for Lead and Offshore plants. The differentiation performance effect for Lead, Source and, to some extent, Contributor plants is consistent with the knowledge-based theory of the firm (Grant, 1996), which conceptualizes firms as institutions for integrating knowledge, primarily embedded in their employees, and the importance of knowledge generation, absorption, and transformation for innovation, one of the competences such plants have (Figure 2, left-hand side) and need to actually achieve differentiation. Why HR is also important for Offshore plants to achieve differentiation performance and for Lead and Offshore plants to achieve cost performance is not clear. Further research is needed to shed light on this observation.

Supplier integration has a positive effect on the cost performance of Server/Outpost plants but not for the other plant types. Placed in an area where advanced suppliers, competitors, research laboratories and customers are located, the chief purpose of these plants is to collect local information (Ferdows, 1997). In addition, they act as an Offshore plant and produce cheap goods, which are sent "back home" for further work or for sale, or supply specific local or regional markets (Ferdows, 1997). Establishing and maintaining good relationships with local suppliers is important for these plants, especially due to the Outpost part of their role. Supplier integration has a negative effect on the differentiation performance of Lead plants. This finding, requiring further investigation is surprising, considering the vast amount of publications on, for example, strategic sourcing, reporting the increasing importance supplier integration for joint technology and product development (e.g. Johnson, 2009; Spina et al., 2013), and experiences with supplier development using approaches such as Toyota's *kyoryoku kai* (supplier association) (e.g. Hines, 1994).

Customer integration affects the cost performance of Offshore plants and the differentiation performance of Lead and Source plants. Offshore plants are located in geographic areas with low cost resources (Ferdows, 1997). Their main purpose is not to serve a local or regional market but, rather, to produce cheap goods for delivery to the parent company or another plant/distribution center of the internal network, both of which are usually located far away. Thus, customer integration represents an effective practice to counterbalance the drawbacks stemming from the relatively larger geographical distance from these key customers and enhance the performance of cost-focused plants. The observation that customer integration also affects differentiation performance is clear for Lead and Source plants. Although the primary purpose of Source plants is low-cost production, their brief is broader than that of Offshore plants – authorized to customize products and make redesign decisions, they have "the same ability to produce … [products or parts] as the best factory in the company's global network" (Ferdows, 1997, p. 76). For Lead plants have the highest levels of competence and authority. Their role includes creating "… new products, processes, and technologies for the entire company" (Ferdows, 1997, p. 76). for both plant types, customer integration through joint decision-making on, for example, product and process design/ modifications and quality improvement, enhances innovation and, in effect, differentiation performance.

Performance effects: a plant type perspective

Lead plants are true leaders in terms of the effective use of practices. With one exception, they have the highest number of practices that have a positive impact on their performance. The exception is supplier integration, which influences their performance negatively. Since Lead plants produce for the global market place, their customers are far away. Therefore, the general rule we argued for above is that they should focus more on integrating with customers, which they do and successfully so, but not necessarily on integrating with suppliers. Integrating with suppliers can increase supply chain resilience (e.g. Vazquez-Bustello et al., 2007; Wieland and Wallenburg, 2013) but standardizing practices and being stuck in a relationship can hinder innovation, too, which is a key issue for Lead plants. Supplier integration may therefore affect differentiation performance negatively for this plant type. Nevertheless, this result needs further and deeper investigation aimed at uncovering the reasons behind implementing these practices.

Source plants also use a diversity of practices effectively. We also checked the level of implementation of various practices for each of the plant types, and found that Source plants are the most intensive users of manufacturing practices – except for Lean and HR, they use all practices significantly more intensively than any other plant type. However, these practices pay off less than in the case of Lead plants, which shows the importance of knowledge and skills accumulation, in which Lead plants have made more progress than Source plants.

Contributor plants use only two practices effectively, HR and advanced technologies, but both practices have a strong positive impact on their differentiation performance.

Offshore plants, many of which are located in the CEE region and in other less developed countries, use the practices to reach better cost performance. This is in line with their main reason of existence.

Server/Outpost plants are established to collect information and may serve a specific local market – thus, the effective implementation of manufacturing practices is not as critical as in other plant types. Among the practices implemented, only supplier integration has some positive effect on cost performance. This might relate to the operation of server plants that can serve the local market more efficiently if they are in a tight relationship with their suppliers (mainly from abroad) – e.g. they can better react to local demand or changes in demand.

Conclusion

Using a wide range of countries and manufacturing practices compared to previous studies, the present research suggests that the "goodness" of manufacturing practices depends on plant role.

The picture emerging from the analysis presented in this paper is that the more competent Lead and Contributor plants use a wider set of operations management practices successfully than the less competent Server and Offshore plants. Differentiation is vital for more competent plants, so they tend to use several practices to improve this performance dimension.

Practices that are best for one type of plant are not necessarily best (e.g. advanced technology), and may actually have negative effects (e.g. supplier integration), for some or all the other types. Most of the findings reported above are consistent with the nature of the types of plants distinguished in this paper.

In the CEE region the ratio of Lead plants is considerably lower, while the ratio of Offshore and Server/Outpost plants is significantly higher. It implies that plants in these regions are more inclined to focus on improving their cost performance.

This study contains some limitations, which are worth considering for further research. Due to the cross-sectional nature of our survey, the long term impact of some practice implementations can not be identified, even if the long-term positive impact of some practices can be far beyond their short-term negative implications. Further research, probably using a longitudinal dataset is needed to reveal these long-term implications. Such a dataset would also help to identify whether there is one best trajectory for developing a plant to a higher competence level or if any trajectory will do. We also need more data to draw more grounded conclusion on the CEE region.

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Insert Appendix 1 here

Table 1 – Plant roles, strategic reasons and competences

Plant roles	**Strategic reason**	**Competences**
Outpost	Access to skills and knowledge	Limited production competence
Offshore	Access to low cost production	Production competence
Server	Proximity to market	Production and limited SCM competences
Source	Access to low cost production	Production and SCM competences
Contributor	Proximity to market	Production, SCM and (limited) development competences
Lead	Access to skills and knowledge	Hub for product/process knowledge

Based on Ferdows (1997), Vereecke and Van Dierdonck (2002), Turkulainen and Blomqvist (2011), and Feldman et al. (2013).

Table 2 – Distribution of the research sample by country and region

Country/region	Frequency	% of total	Country/region	Frequency	% of total
Hungary	28	5.9%	Sweden	19	4.0%
Romania	14	3.0%	Switzerland	14	3.0%
Slovenia	10	2.1%	**WE total**	**204**	**43.3%**
CEE total	**52**	**11.0%**			
			Brazil	18	3.8%
Belgium	17	3.6%	Canada	8	1.7%
Denmark	22	4.7%	China	41	8.7%
Finland	12	2.5%	India	42	8.9%
Germany	7	1.5%	Japan	56	11.9%
Italy	27	5.7%	Malaysia	8	1.7%
Netherlands	28	5.9%	Taiwan	20	4.2%
Norway	20	4.7%	USA	22	4.7%
Portugal	21	4.5%	**RoW total**	**215**	**45.6%**
Spain	17	3.6%			
(continued…)			**TOTAL**	**471**	**100.0%**

CEE – Central and Eastern Europe, WE – Western Europe, RoW – Rest of the world (America, Asia)

Table 3 – Distribution of the sample by size and industry

Employees	Frequency	% of total
Small (<250)	158	33.5%
Medium (250-500)	100	21.2%
Large (>500)	211	44.8%
Missing	2	.4%
TOTAL	**471**	**100%**

ISIC code*	Frequency	% of total
25	140	29.7%
26	63	13.4%
27	85	18.0%
28	104	22.1%
29	55	11.7%
30	24	5.1%
TOTAL	**471**	**100%**

**ISIC 25: Manufacture of fabricated metal products, except machinery and equipment; 26: Manufacture of computer, electronic and optical products; 27: Manufacture of electrical equipment; 28: Manufacture of machinery and equipment not elsewhere classified; 29: Manufacture of motor vehicles, trailers and semi-trailers; 30: Manufacture of other transport equipment.*

Table 4 – Convergent and discriminant validity assessment

	CR	AVE	DiffPerf	CostPerf	Tech	Qual	Lean	HR	SuppInt	CustInt
DiffPerf	.804	.579	*.761*	-	-	-	-	-	-	-
CostPerf	.754	.509	.467	*.714*	-	-	-	-	-	-
Tech	.779	.541	.487	.188	*.736*	-	-	-	-	-
Qual	.826	.612	.497	.190	.705	*.783*	-	-	-	-
Lean	.730	.580	.507	.227	.531	.562	*.761*	-	-	-
HR	.754	.507	.483	.244	.337	.568	.510	*.712*	-	-
SuppInt	.852	.591	.373	.235	.507	.643	.459	.458	*.769*	-
CustInt	.874	.635	.380	.201	.516	.618	.352	.291	.705	*.797*

CR – construct reliability, AVE – average variance extracted, square root of AVE – values on the diagonal, remaining values – pairwise correlations between constructs

Table 5 – Regional distribution of plant type clusters in Europe

Plant type	**CEE** Freq. (pct.)	**WE** Freq. (pct.)	**z-score (p value)**
Lead	1 (1.9%)	77 (37.7%)	**-5.0099 (.000)**
Source	15 (28.8%)	41 (20.1%)	1.3622 (.174)
Contributor	8 (15.4%)	37 (18.1%)	-0.4655 (.638)
Offshore	20 (38.5%)	36 (17.6%)	**3.2411 (.001)**
Server/Outpost	8 (15.4%)	13 (6.4%)	**2.1141 (.035)**
TOTAL	**52 (100%)**	**204 (100%)**	**-**

Table 6 – The impact of practices on cost performance

Predictors	**LEAD**	**SOURCE**	**CONTRIBUTOR**	**OFFSHORE**	**SERVER/ OUTPOST**
Model 1 – control variables					
Size	.074	.027	.016	.046	-.080
Age	-.054	-.008	-.001	.080	-.201
Develop	.215*	.006	.038	-.169	.161
Model 2 – manufacturing practices					
Tech	-.075	.191	.251	.297	.067
Qual	-.221	-.214	-.421	**-.773****	-.004
Lean	.159	.077	.259	.074	-.088
HR	**.342***	.130	.287	**.577****	.050
SuppInt	.112	.034	.199	.005	**.750***
CustInt	.108	.222	-.052	**.552****	-.349
Adj-R^2	.110	.027	.083	.214	.182
F-value (p-value)	F(9, 94)=2.414 p=.016	F(9, 99)=1.331 p=.231	F(9, 70)=1.799 p=.084	F(9, 63)=3.177 p=.003	F(9, 66)=2.860 p=.007

*Regression coefficients significant at *** p<.001, **p<.050, *p<.010*

Table 7 – The impact of practices on differentiation performance

Predictors	**LEAD**	**SOURCE**	**CONTRIBUTOR**	**OFFSHORE**	**SERVER/ OUTPOST**
Model 1 – control variables					
Size	**.290****	-.042	.117	.200	-.009
Age	-.116	-.100	.072	.064	-.143
Develop	-.107	**-.286****	**-.248***	**-.324***	-.201
Model 2 – manufacturing practices					
Tech	**.331****	**.354***	**.324****	.282	.167
Qual	-.199	-.182	-.245	-.330	.431
Lean	**.267****	**.255***	.242	.195	.083
HR	**.528*****	**.294****	**.437****	**.510*****	.105
SuppInt	**-.210***	-.240	-.061	.081	-.235
CustInt	**.301****	**.273***	.163	.259	.142
Adj-R^2	.646	.405	.436	.520	.412
F-value (p-value)	F(9, 94)=21.845 p=.000	F(9, 99)=9.156 p=.000	F(9, 70)=7.778 p=.000	F(9, 63)=9.660 p=.000	F(9, 66)=6.846 p=.000

*Regression coefficients significant at *** p<.001, **p<.050, *p<.010*

Figure 1 – The research framework

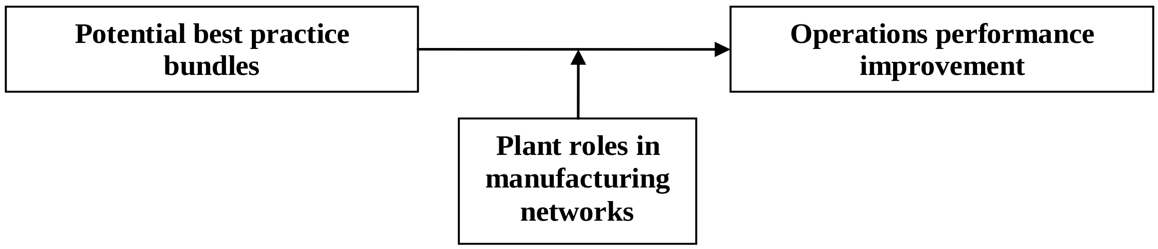


Figure 2 – Competences (left) and strategic location (right) of plant type clusters

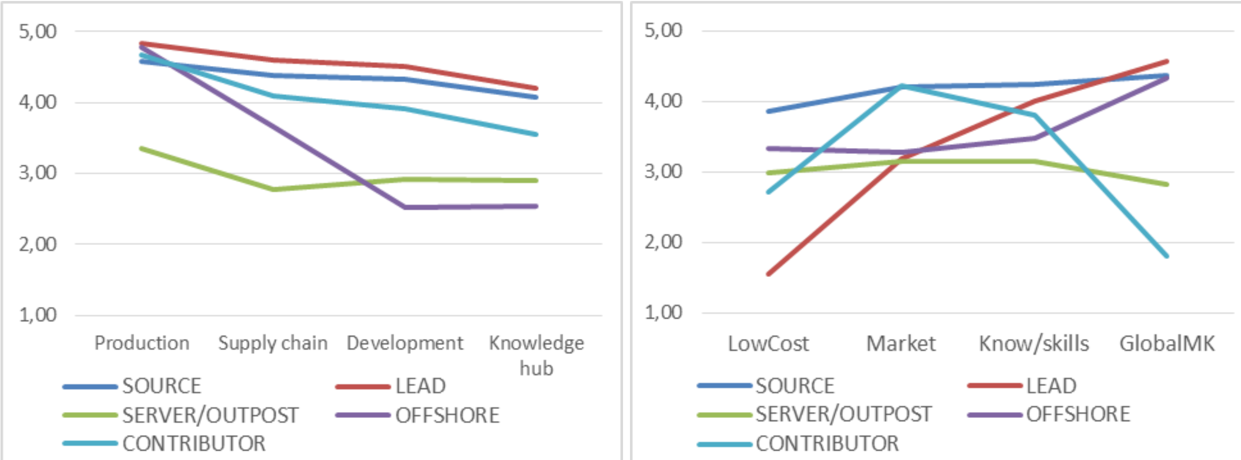
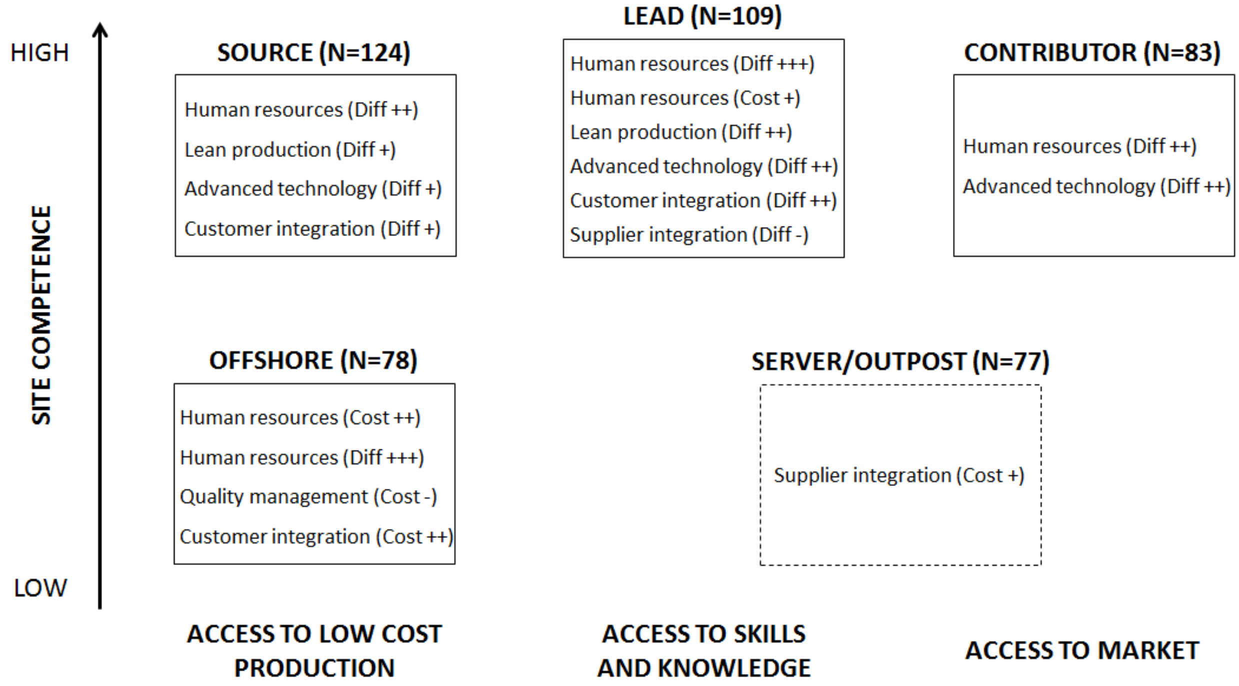


Figure 3 – Best practices and plant roles



Significant positive/negative effect on cost or differentiation performance at +/- p=.05, ++/-- p=.01, +++/--- p=.001 level

Appendix 1 – Bundles of manufacturing practices and performance constructs

Construct	Item	Item description	Mean	SD	Path loading***
Practices					
Tech	*T1a1*	Advanced processes	2.85	1.32	.684
	T1b1	Factory of the future, smart/digital technology	2.66	1.19	.770
	T1c1	Process automation programs	2.97	1.25	.750
Quality	*Q1a1*	Quality improvement and control	3.40	1.04	.762
	Q1b1	Improving equipment availability	3.19	1.08	.810
	Q1c1	Benchmarking/self-assessment techniques	2.92	1.23	.775
Lean	*PC3a1*	Restructuring and streamlining for process focus	3.57	1.06	.865
	PC3b1	Implementing pull production	3.39	1.13	.641
HR	*O7a1*	Delegation and knowledge of workers	3.22	.95	.743
	O7b1	Open communication between workers & managers	3.57	1.01	.766
	O7f1	Improving workers' flexibility	3.35	.96	.618
SuppInt	*SC6a1*	Information sharing with key suppliers	3.28	.99	.704
	SC6b1	Collaborative approaches with key suppliers	3.24	1.03	.784
	SC6c1	Joint decision making with key suppliers	3.06	1.04	.828
	SC6d1	System coupling with key suppliers	2.97	1.11	.755
CustInt	*SC6f1*	Information sharing with key customers	3.08	1.10	.742
	SC6g1	Collaborative approaches with key customers	3.03	1.13	.760
	SC6h1	System coupling with key customers	2.91	1.19	.840
	SC6i1	Joint decision making with key customers	3.10	1.08	.840
Performance					
DiffPerf	*Qual*	Quality performance	3.06	.74	.801
	Flex	Flexibility performance	3.08	.71	.717
	Deliv	Delivery performance	2.84	.73	.762
CostPerf	*B6m1*	Unit manufacturing cost	2.54	.94	.814
	B6n1	Order cost	2.42	.85	.706
	B6o1	Manufacturing lead time	2.79	.95	.606
Underlying first-order constructs of DiffPerf					
Qual	*B6a1*	Conformance quality	3.11	.98	.842
	B6b1	Quality and reliability	3.24	.95	.839
Flex	*B6c1*	Volume flexibility	3.27	.98	.818
	B6d1	Mix flexibility	3.18	.96	.709
Deliv	*B6i1*	Delivery speed	3.17	.96	.814
	B6j1	Delivery reliability	3.20	.98	.909

**** All loadings significant at p=.001*

Absolute fit indices: χ^2*=561.391, p=.000, df=319,* χ^2*/df=1.760, GFI=.921, RMSEA=.040 (p=.999), SRMR=.0394*
Incremental fit indices: NFI=.912, CFI=.959, TLI=.952