

INNOVATIVE AND LEAN CONSTRUCTION SUCCESS FACTORS FOR COMPONENT SUPPLIERS

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ABSTRACT

Compared to other industries, the construction industry has not achieved the same improvements in terms of productivity, customer benefits, and quality. Low innovation activity and supplier cooperation in construction might be one reason for the low level of large-scale improvements. However, the search for improvements in the construction industry has led to interest for new innovations. One way for the construction industry to improve the building process is through use of innovative managerial concepts, as lean and agile construction. The aim of this work is to categorize Swedish component suppliers of different construction materials that act with a clear supplier coordinator commitment, on the basis of lean and innovative business strategic concepts. A secondary purpose is to find success factors for the component suppliers within the derived lean and innovative concepts. Results from the exploratory comparative study of steel-, concrete-, and timber component suppliers indicate differences between different construction material suppliers. This study also suggests a possible strategy where products accompanied with technical support and software knowledge offered to the customer, customer integration in product development, and use of product development networks to generate new knowledge and components seems to be distinct success factors.

KEY WORDS

Lean construction, lean thinking, innovation, component suppliers, success factors

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INTRODUCTION

Henry Ford developed the automobile industry from craftsmanship into a developed process that eventually evolved to lean production (Womack et al. 1990) and lean thinking (Womack and Jones 2003). Attempts have been made to develop lean (technical efficiency of processes) and agile (customization and effectiveness) construction (Naim and Barlow 2003). It is argued that the focus of developing construction should be on the basics of lean thinking, i.e. transformation, flow, and value (Koskela 2003). In the large enterprise manufacturing industry, supply chain management (SCM) with effective integration of the major supply chain components; customers, manufacturing and suppliers, is key (Tan et al. 1999). Within the area of construction SCM, project management upstream with suppliers and downstream with customers has been treated by, for example, Lamming (1993). This focus on suppliers and customers emphasizes a strategic vision of lean production, suggested as the lean enterprise. This paper presents an exploratory, comparative focused study of three different Swedish material suppliers of construction components that act with a clear supplier coordinator commitment. Based on a deductive approach, lean and innovative concepts are used to explain and categorize success factors for component suppliers.

LEAN PRODUCTION AND INNOVATION

The manufacturing industry appears to have been successful in applying methods to render the supply chain and production more efficient. However, the construction industry has not reached the same productivity benefits as e.g., the automobile industry. Actors in the construction industry point to the “one-of-a-kind, project-based nature” of construction as evidence that the innovations of manufacturing cannot be applied to construction (Crowley 1998). In construction, also process innovations are uncommon; instead typical innovations in construction are product innovations by material and component manufacturers (Koskela and Vrijhoef 2001).

The theoretical background of the lean production paradigm is lean thinking (Womack and Jones 2003). The principal foundation for lean thinking is the concepts of value, value stream, flow, pull and perfection, or transformation, flow and value (Koskela 2003). The foundation for the concepts of value, pull, and perfection can be related to the basis of the customer’s perspective, as customer requirements of finished products or instant improvements driven by customers’ demands. The concepts of value stream and flow refer to all necessary activities - information and materials conversion - needed through the whole process, from the raw material to a finished product. The salient feature of lean thinking is thus the management of the conversion process to promote flow. Based on this, the lean paradigm ranges over four functional areas related to the product (conversion) process; lean product development, lean procurement, lean manufacturing, and lean distribution (Karlsson and Åhlström 1996).

Research within lean construction seems to focus on holistic and theoretical studies of the whole lean production process (Saad et al. 2002, Ballard and Howell 2003, Koskela 2003). However, one of the most critical factors of lean production principles appears to be the management of external relationships rather than internal operations (Karlsson 1992, Panizzolo 1998). In the Swedish construction sector and within construction research, the

interest of finding key characteristics and success factors for component suppliers is increasing and it is this potential that motivates this paper. Hence, this paper highlights the characteristics of the organized external network while excluding the manufacturing process and internal organizational questions. The same type of differentiation has formerly been developed into a model where the lean procurement and the lean distribution principles result in the lean enterprise (Karlsson and Åhlström 1997). Based on this demarcation, the aim of the paper is to investigate how supplier coordinating component suppliers in construction act in their marketplace towards other suppliers and customers and how these can be categorized on the basis of lean and innovative concepts derived from literature. A second purpose is to identify strategic success factors within the framework of the lean and innovative concepts.

THE LEAN PARADIGM AS AN INNOVATION

Culture of innovation in the firm is almost connected to the leanness of a firm. Thus, the adoption of lean management principles and techniques can result in an innovative culture (Bröchner et al. 2002). Innovative activities can be divided into three broad categories:

- **Product development or improvements** (Montoya-Weiss and Calantone 1994, Cooper 1996).
- **Process innovation**, regarding improved processing or manufacturing, where a firm's process innovation culture depends on, e.g., workers integration and organization structures (Smeds 1994, Martins and Terblanche 2003).
- **Business systems**, regarding new or improved business and marketing practices (Hovgaard and Hansen 2004) that are customer and market-oriented, focusing on solving customers problems (Martins and Terblanche 2003).

LEAN AND INNOVATIVE SUPPLIER AND MARKET CONCEPTS

The reviewed principles are related to each other and linked to the features of the lean enterprise. Without aiming for a direct comparison, the condensed concepts based on parts of the lean and innovation theory is depicted in Figure 1. The figure explains the evaluated relationship between the explored basic principles of lean thinking, lean production and innovative theory to our conceptualization, the lean and innovative supplier and market concepts. The concepts in Figure 1 - knowledge networks (KN), supplier networks (SN), customer focus (CF), and customer integration (CI) - are labelled by considering the grey coloured area of Figure 1. This means that the principles found in the literature regarding the external supplier-market focus of lean thinking and innovative business systems can form a base to describe lean and innovative supplier and market concepts. Each concept is explained below.

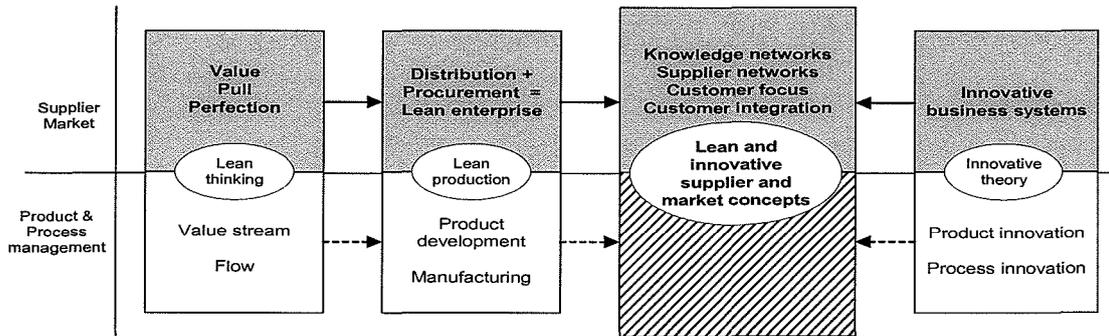


Figure 1: Lean and innovative supplier and market concepts.

SUPPLIER FOCUS CONCEPTS

Knowledge networks

The principle of knowledge network relies on the ability to collect knowledge from others into the firm and to keep the obtained knowledge inside the organization. Using knowledge networks implies that the company has an ambition to learn from specialists in different areas such as technical consultants and suppliers as well as competitors (Karlsson and Åhlström 1997). The lean enterprise can benefit by learning from larger suppliers who may already be a partner in another supply chain (Jina et al. 1997) along with establishing a long-term agreement cooperation that creates a rational framework for sharing profits (Lamming 1993). Research shows that development in networks is very often beyond the capability of a single firm and that efficient utilization of external and internal capacity will form the “total capacity” that enables a firm to better meet customers demands (Awuah 2001).

Supplier networks

The concept of supplier networks implies that a company has strategic and long-term supplier relationships. Also, the lean producer assigns a whole subcomponent instead of several individual parts meant to be put together by the producer (Karlsson 1992). The lean enterprise therefore often becomes a “system-integrator” that from our point of view is a supplier coordinator commitment, providing specialized parts and final assembly of subsystems using a network of suppliers, as Figure 2 shows.

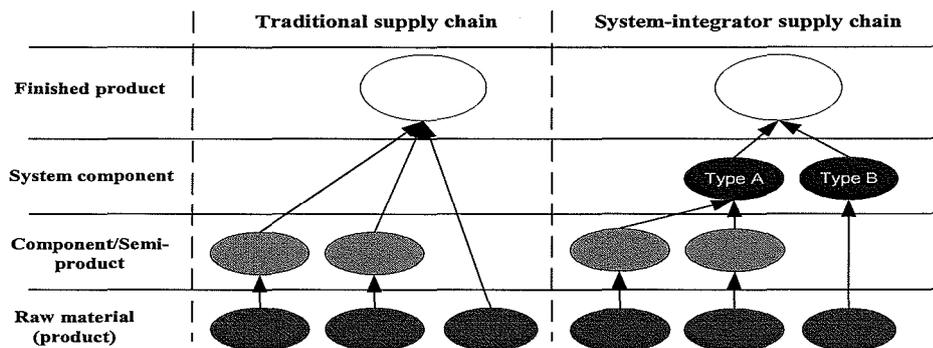


Figure 2: Traditional supply chain and system-integrator supply chain.

Therefore, the system integrator's major role is design, marketing, and service rather than production (Crowley 1998). If a supplier is not involved in, e.g. the component design, the manufacturer has to invest extra time and resources to solve any problem their suppliers encounter when manufacturing a part they have not designed (Sanchez and Pérez 2001). This highlights the importance of establishing closer and longer-term relations with suppliers, not only at a logistic level, but also at the technological/strategic level (Lamming 2003).

MARKET FOCUS CONCEPTS

Customer focus

If a company have functional customer focus it offers activities and services beside the main product. A complete service raises the value and the customer satisfaction for the product compared to similar products marked by competitors (Crowley 1998). Therefore the lean enterprise system provides loyalty from the buyer and makes it extraordinarily hard for new competitors to gain share (Womack et al. 1990). Constant innovations are a competitive advantage for the long-term survival of an enterprise because it allows the company to better meet customer needs (Cooper 1996). A wide range of choices for the customer can also be delivered through the use of standard components flexible in assembly (Gann 1996). Simultaneously managers must shift focus from their existing organisation and production to the customer (Kippenberger 1997). Companies that use appropriate innovation management in a coherent and rational manner will therefore better provide the total value that customers demand (Naim and Barlow 2003).

Customer integration

Customer integration implies that a company work in close relationships with customers. A lean enterprise should be part of a global network where process integration is particularly important (Karlsson and Åhlström 1997), meaning that no one should produce a good or service until the customer asks for it. Instead of pushing complete products at customers, the customer communicates demand through pull (Green 1999, Womack and Jones 2003). Continuous improvements are important since customer demands are constantly increasing

and new technical solutions and enterprises are emerging. Hence, it is important that improvement suggestions are solicited from customers (Forza 1996). The lean enterprise has to develop a “customer-in” organization whose important topics are the capability and competence of the sales network, the exchange of information with customers, and customer involvement in product planning and design (Panizzolo 1998).

EMPIRICAL RESEARCH METHOD

A comparative approach based on exploratory studies of component suppliers acting as system-integrators in the Swedish construction industry was undertaken. Focused studies were chosen, whose characteristics are that a minority of cases is studied and that the study aims to explain a certain situation with an average level of generalization. A critical moment for comparative studies is the election of cases and the selection regarding generalization and explanation (Ragin 1987). Here, five component suppliers were chosen as being representative within the material areas of steel, wood, and concrete in the Swedish construction material industry. The five companies being both small and large were solely compared regarding their business strategies concerning their supplier and customer relationships.

In the classic paradigm of comparative research, studies are often qualitative to attain a wider understanding. Consequently, the research was conducted qualitatively involving personal interviews. Respondents from each company were chosen from comparable functions in the companies’ organizational structures and the same questionnaire was used to ensure that the collected data were likely to demonstrate the same characteristics.

DESCRIPTION OF COMPANIES

Company A

Company A is subsidiary to one of Scandinavia’s largest manufacturers of thin sheet steel products. The firm’s main purpose is to manufacture and market shelf products in steel and aluminum for roofs, walls, and joists to building contractors and the material trade. The products are based on a mature in-house developed technology. The company offers several established products and some new innovative prefabricated steel-based wall elements and is a well known actor on a mature market. Since the company manufactures all of their products they have a large production facility. Three people were interviewed; one business developer manager within sales, one product developer manager, and one person from the sales staff.

Company B

Company B is a member of the concrete group Consolis, the largest manufacturer of prefabricated concrete elements in Europe. The company produces a wide range of prefabricated concrete elements for walls and joists and thus has a large production facility. Company B have a well developed knowledge about the products and is a well known actor on a mature market. The company’s main customers are building proprietors within the industrial sector. One project development manager with competences within sales and technical development gained from working in several positions within the company was interviewed.

Company C

Company C is owned by the German concrete group Heidelberg. Its business concept is to provide building proprietors constructing residential blocks with project adapted system solutions and concrete products. The studied company has just like companies A and B, several years ago participated in the development of the products for walls and joist that is offered to the customer. They have a well developed knowledge about the products and is a well known actor on a mature market. Company C also offer an innovative product concept that consists of shell elements of concrete that are partly prefabricated and partly finished on the construction site. The production capacity of the studied company is large. One senior manager in the housing division, responsible for the subdivisions of marketing, selling, product development, and manufacturing, was interviewed.

Company D

Company D is a firm within a Swedish timber association where the business concept is to market and sell timber based products and systems for multi-storey houses to building proprietors on the European market. The technology for multi-storey timber frame houses is to date not well known and developed structural systems are lacking; why company D is rather innovative since they have developed timber joists elements and a new advanced timber component. The company has no manufacture capacity in-house; instead they utilize a business relationship with one strategic production company. The respondent in company D is a salesman, with product development knowledge and management experience.

Company E

The business concept of company E is to sell and market solid timber house components for residential blocks and detached houses to building proprietors. This concept means that the company offers only a few wall, roof and joists components to the customer. The studied company has no own production capacity since the solid timber elements are imported. Though the company does not manufacture any products, they have participated in the development of new solutions for solid timber joists. In company E, two owners were interviewed; one mainly responsible for selling, and customers, the other works with marketing and product development.

Table 1 shows comparable values for the studied companies.

Table 1: Age on market, turnover (2002), number of employees (2002), and ROA*(mean value 1999-2002).

	Age on market	Turnover (M Euro)	Number of employees	ROA
A	37	80	197	0,16
B	62	115	977	0,09
C	59/6**	63	510	0,15
D	3	0,8	7	-0,46
E	9	0,6	3	0,01

* ROA is calculated as net income divided by total assets and indicates financial performance. Higher value indicates comparatively better financial performance. ** Age on market after fusion

RESULTS AND ANALYSIS

The empirical findings of the studied component manufacturers strategies and external networks are summarised below. The results are analyzed and categorized in relation to the lean and innovative supplier and market concepts in Figure 1.

KNOWLEDGE NETWORKS (KN)

Company A is a mature company where no dramatic changes occur and they have all needed competence within the company. Similarly, the company does not consciously try to profit knowledge input from suppliers or consultants to the product development or manufacturing process. Both companies B and C hire consultants, often technical, when new knowledge is needed. They also attempt to give their employees' additional knowledge by using their respective networks. Company D has since the start spent efforts on technical improvements and continuously utilized an external network of consultants and researchers for the planning and designing process. All employees have participated in product development, which explains why the company today has knowledge built into the organization. Finally, company E really makes use of competence outside the company organization through a broad knowledge network of consultants and researchers. Company E only has three employees and none of them have proper technical knowledge.

SUPPLIER NETWORKS (SN)

Company A believes that they have all the necessary competence with most product components being manufactured within the company. However, company A acts as a system integrator of type B (Figure 2), since raw material is supplied from the parent company. Company B's turnover consists of 30-40 % of services provided; implying that company B has several supplier relationships. Occasionally, company C buy the same type of concrete elements as they produce by themselves from other concrete manufacturers when the own capacity is not enough. The company also buy non-concrete products as e.g., windows and doors from other suppliers. In the past company D managed their own manufacturing of structural wood components. Today, the manufacturing of the timber components is outsourced and other subcomponents are supplied from the supplier network. Company E does not manufacture the timber components by themselves. Instead they act as a system-integrator of type A and buy the wood elements and other components from suppliers in their network and coordinate services as design and assembling.

CUSTOMER FOCUS (CF)

The customer focus for company A has taken the form of a powerful distributor network, customer services such as software methods for calculation, design knowledge they share with their customers, and a strong confidence in the well-known owner's name. Company B manufactures concrete elements, but they have no constraints to sell buildings containing concrete. Instead, they focus on offering the customer the product the customer asks for. Company B says that their customer focus implies that they can handle flexibility and late decisions from the customer. Company C have a distinct customer focus and emphasize their solid experience and knowledge that is used when products are designed to different projects.

In this manner customers buy knowledge built-in to the product. The strategy of company D is a clear system thinking where the customer focus is to share its knowledge about timber house building via a handbook. Company E also have a low, or blurred, customer focus and relies on that they have supplied timber components to several finished houses, now used as reference objects.

CUSTOMER INTEGRATION (CI)

Company A struggles with large costs caused by the location of the manufacturing plant in relation to the main market. Therefore, company A focuses on retailers to enable close and daily contact with customers, and they also arrange different customer activities. However, they do not utilize customer integration in product development. Company B focuses on key customers since around 80% of their sales are to previous customers. They also arrange customer activities and most product development is done in collaboration with customers. Company B claims a clear pattern between products developed in collaboration with the customer and marketability. Contrary to this observation, company C has not seen any difference according to sales between their own developed products and products developed in collaboration with customers. However, company C perceives a connection between sales and the vicinity to customers and therefore the company has enlarged and spread the sales staff organization during a fusion and reorganization six years ago to enable closer contact with the customer. Company C also arrange different customer activities. Company D tries to be at the construction site as often as possible, since these contacts present the best input for improvements. They also actively work with development ideas from customers. Finally, company E works with an architect who has contact with potential customers and examines the customers demand. The company also often visits customers at the construction site. However, company E is a micro company; therefore it is hard for them to relate the organization towards customers and main market segments.

Table 2 shows the categorization of the studied companies within the theoretical derived supplier and market concepts. Within each concept the firm's salient strategy is shown. A description in italic text in the "CF"-column describes the company's main market focus.

Table 2: Categorization of companies in lean and innovative supplier and market concepts.

		Supplier integrated strategy		Market integrated strategy	
		KN	SN	CF	CI
A			System integrator B* (Buy raw material/ manufacture components)	<i>Building contractors /material trade Shared knowledge Technical support</i>	<i>Make to stock** Sales network near customer Customer activities</i>
B	"When needed"		System integrator A* (Manufacture components buy some)	<i>Building proprietors (industry) Material independent Flexibility</i>	<i>Make to order*** Sales network near customer Customer activities Customer involvement in product development</i>

C	"When needed"	System integrator A* (Manufacture components/ buy some)	<i>Building contractors</i> (<i>residential blocks</i>) Knowledge built-in to the product	<i>Make to order***</i> Sales network near customer Customer activities Effective customer involvement in product development
D	Building phase /Always	System integrator A* (Buy components/ Offer assembling)	<i>Building proprietors</i> (<i>residential blocks</i>) Shared knowledge via handbook	<i>Make to stock**// order***</i> Sales network near customer Customer involvement in product development
E	Always Broad KN	System integrator A* (Buy components Offer assembling)	<i>Building proprietors</i> (<i>residential blocks/ detached houses</i>)	<i>Make to order***</i> Customer activities Customer involvement in product development

* System integrator Type A respectively Type B according to Figure 2. ** Make to stock implies standard products. *** Make to order contain products that are planned/designed/manufactured after customer order.

DISCUSSION AND CONCLUSIONS

Based on the pooled integrated supplier (KN&SN) and market (CF&CI) concepts a company may be categorized. A company that work with a high value of integrated supplier focus and integrated market focus is defined as the "lean enterprise" in Figure 3a. The lean enterprise here briefly means that the company collect knowledge from others (Karlsson and Åhlström 1997, Jina et al. 1997) and able the knowledge to stay within the company, purchase whole subcomponents from suppliers, add value to the product via adding activities (Crowley 1998) and involve customers in product development (Forza 1996). The suggested "market enterprise" focus customer involvement and strive hard to satisfy the customer, but does not make use of other suppliers or external knowledge in any larger extent. The "supplier enterprise" utilizes external knowledge and suppliers but does not have a clear focus on the market and customers needs. The "internally enterprise" develops and manufacture all products in-house, to stock, and focus more on the own production than customers needs, which is the opposite of lean supplier thinking according to Kippenberger (1997).

By using Table 2 the companies' integrated supplier and market strategy, and the companies' age on market, with contemporaneous noting of the ROA-values, are shown in Figures 3a and b.

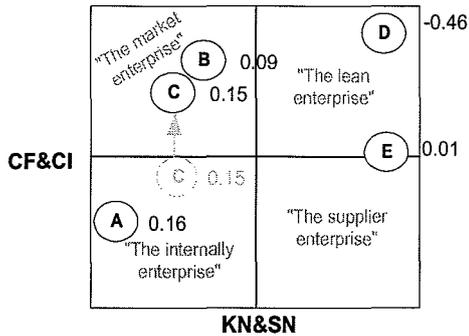


Figure 3a: Market focus vs. supplier focus.

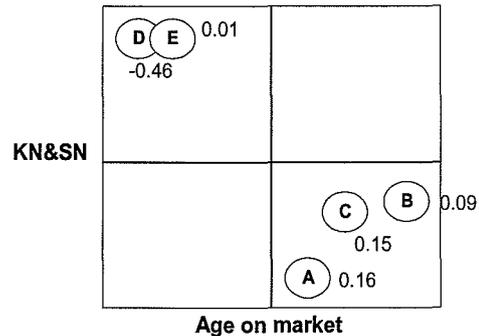


Figure 3b: Supplier focus vs. age on market.

Figure 3a displays two distinct company groupings according to supplier focus. The three steel and concrete suppliers (A, B, and C) show a low degree of knowledge and supplier network utilization but also high ROA-values. However, the low degree of supplier focus (KN&SN) seems to be independent of the chosen strategy concerning market focus (CF&CI) when ROA is concerned. The opposite is shown by the two timber suppliers (D and E) within the “lean enterprise quadrant”, with high supplier and market focus, but low ROA. Large companies (A, B, and C) seem to have a low degree of supplier focus, while small companies (D and E) have preferred to jointly have a high degree of supplier and market focus. Interesting to note is that the mature company C went through a company fusion six years ago, with a shift of strategy towards a higher market focus. Figure 3b clearly shows the low integrated supplier focus of the mature steel and concrete suppliers and the higher degree of supplier cooperation of the younger and smaller timber suppliers.

This study surprisingly indicates that the companies that make use of a “lean enterprise strategy” have not succeeded on the market, at least according to their ROA-value. This might be explained by several circumstances. Companies D and E are newcomers that sell and develop timber components. Timber is a material that has not yet gained confidence from the Swedish construction market. Both companies have also chosen a high level process innovative strategy. This apparently is the wrong way to go as the “change competence” is low in construction, especially concerning process innovations (Koskela and Vrijhoef 2001). The mature and more successful companies A, B and C have clearly developed another strategy, namely focusing on several consecutive product innovations through the years, while today not involving suppliers or utilizing knowledge networks in this work.

Based on the results and discussion, it is possible to outline success factors, based on the supplier and market concepts, used by the studied companies. The results also incline that the success factors should be prioritized in two steps:

- 1) **Customer Focus:** Knowledge influenced by key customers increases the value and competitiveness of key products. Value raising activities is exemplified by company A that offers technical support and software knowledge to the customer, company C that

offers the knowledge built-in to the product and company D that provide knowledge to the customer via a handbook.

Customer Integration: *Organizational design influenced by chosen customer niche, and customer involvement in product development.* To enable close relationships with customers, companies (A, B, C and D) have their sales network oriented after the customer. Customer involvement is utilized in the product development by four of the five studied companies. However it seems to have minor effects except for company B.

- 2) **Knowledge Networks:** *Acquiring of knowledge from others, striving for knowledge building inside the organization through employees participating.* The majority of the studied companies acquire knowledge from others when the internal knowledge is not enough, and try to build in the new knowledge to the organization.

Supplier Networks: *Utilizing of supplier networks and focusing on the final assembly of subsystems instead of focusing on the own production.* This is exemplified by companies D and E that in a high extent use supplier networks in their role as system-integrators, focusing on the final assembly of subsystems, with design and assembling built in to the product.

It must be noted that because of the exploratory comparative research setting in the study, it is only possible to achieve a low or average level of generalization which has to be considered regarding these conclusions. The fact that the lean and innovative thinking seems not to be successful for companies D and E might also be explained by the fact that these two companies have been studied too early. These companies have been acting on the market for only a few years. Therefore, a longitudinal study of how the companies act and develop in the future is interesting. It is also interesting to investigate if the strategy of mature companies with low supplier focus is prosperous and competitive and if the younger companies will follow the same strategy.

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