Digital collaboration within the supply chain: New booster for hidden lean potential.

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Abstract
This paper explores the hidden lean potential exposed by manufacturers' usage of enterprise resource planning (ERP) systems. The potential can be classified into three types: unlocked lean potential in a connected ERP system, unlocked lean potential in an un-connected ERP system, and the lean potential for further unlocking in companies that do not use ERP systems when collaborating with suppliers/customers. Empirical data is obtained from two cases of manufacturing companies in Sweden and one ERP system company. The findings indicate that hidden lean potential can be unlocked through digital collaboration within the supply chain.

Keywords: lean manufacturing, digital technologies, supply chain

Introduction
Nowadays a significant number of manufacturing companies around the world have become influenced by lean philosophy and actively use its techniques to increase competitiveness and profits (Fritzen et al., 2016; Hoe et al., 2017; Womack, 1990). Supply chain success is based on collaboration and trust, with a common goal to create more value working in a synchronized manner for mutual benefit. The lean approach spread over the supply chain share a common goal of value creation through the reduction of waste through the whole supply chain (Christopher et al., 2006; Goldsby et al., 2011). Technological progress offers manufacturers ERP systems that are aligned with lean values and increase the efficiency of manufacturing companies through the accurate data management and transparency of the processes (Palaniswamy and Frank, 2000). ERP systems have taken leading role in developing strategic decisions within manufacturing companies (Yen and Sheu, 2004). However, it is still unclear how to gain maximum benefit from the technological options available for modern manufacturers. Does a digital supply chain allow lean manufacturers to become even leaner, by discovering new lean potential? McDermott (2016) provide statistics showing that overall, digital supply chains lead to a 20% reduction of procurement costs, a 50% reduction in supply chain costs, and an increase in revenue of 10%. The figures suggested by consultancy companies promise a reduction of costs through investments into technologies. However, it is still to be discovered, whether the usage of technologies at a supply chain level can boost the internal lean potential of manufacturing companies. The purpose of the study is to discover hidden lean potential through ERP systems and the supply chain.

Lean & Supply Chain

Goldsby et al. (2006), provide a description of three of the most common and debated supply chain strategies: lean, agile and hybrid (leagile). Supply chain strategy should be designed in a logical sequence from market identification to the establishment of performance metrics. The approach aims to improve competitive standing by achieving the real market winning criteria (Towill and Christopher, 2002). Christopher and Towill (2001), support the development of a hybrid strategy to create a cost-effective supply chain. The key success factor for lean or agile strategy derives from the market selection, where one of the strategies is the most convenient approach to reach competitive advantage. Christopher and Towill (2001) proposed a framework combining lean and agile philosophies to achieve a greater effect within the supply chain. The hybrid strategy should reflect on market conditions and is very context specific. Martínez-Jurado and Moyano-Fuentes (2014) evaluated the links among lean management, supply chain management, and sustainability. According to the authors, companies would like to adopt lean management, but they are also concerned about the impact they have on society through their activities. The impact is not an isolated scene within the organization. Instead, it is spreading through the whole supply chain directly or indirectly.

Value management within the supply chain is a challenging task. When the goal is to make the supply process lean for the benefit of the supply chain, then responsibilities should be distributed following a different strategy (Lamming, 1996). Christopher et al. (2006) discuss the importance of the supply chain strategy selection based on analysis of the product, market, and company. Key dimensions in the selection process should be based on replacement lead-times and predictability of demand, which can be enriched further with the nature of the product and its life cycle. Naylor et al. (1999), arguing that consideration of market knowledge is primarily important when integrating the lean or agile manufacturing paradigm. They suggest avoiding the isolated consideration of operations management in the manufacturing sector. Operations need to be considered in combination with a supply chain carefully combining both lean and agile paradigms towards “leagility” (Naylor et al., 1999).

Manufacturing & ERP

ERP implementation is a complex act that manufacturing companies face to improve the interaction between customers and suppliers. According to Duplaga and Astani (2003), smaller companies are more successful in implementing ERP systems in the manufacturing sector. However, companies are more likely to view ERP implementation as the beginning of the development. Linking customers and suppliers to the ERP system in a perspective is more likely to be implemented by bigger manufacturers (Duplaga and Astani, 2003). According to Palaniswamy and Frank (2000), ERP systems enhance manufacturing performance. An ERP system is a powerful tool for coordinating production, reengineering business processes, and establishing a competitive innovative environment for future survival in the global marketplace (Palaniswamy and Frank, 2000). Yen and Sheu (2004) discuss challenges that companies have faced in implementing ERPs and the uncertainty about the benefits expected after the implementation. On the other hand, research state that failures are the results of business problems, not technical ones. Yen and Sheu (2004), suggest aligning ERP implementation with a competitive strategy. Software customization, information sharing, data accessibility, software maintenance, proactivity of managers, national culture, and government/corporate policies are among the key factors that need to be considered for successful ERP implementation in manufacturing firms.

Raymond and Uwizeyemungu (2007), developed a framework to analyze the propensity of small and medium enterprises (SMEs) in adopting an ERP system. The framework is a set of relations between environmental, organizational and technological contexts, leading towards an ERP adoption profile. The authors suggest starting from the assessment of the manufacturing company to evaluate how an SME is ready to adopt computer-integrated manufacturing technologies and an ERP system. Muscatello et al. (2003) propose a set of planning activities during the ERP implementation process for SMEs, such as strategic objectives and top management involvement, reengineering efforts, enterprise system analysis, and ERP profiles of the companies. Another important set of activities in the case of SMEs relates to installation activities including education and training requirements, project monitoring and reporting, and overall project performance.

Baki and Çakar (2005) investigated Turkish manufacturing companies using ERP systems, where the majority of the companies used their own program to regulate the process. The second most popular result of their study was an absence of unified software. A minority used manufacturing resource planning software or materials requirement planning software. Manufacturing companies in the minority that used the ERP, had a list of selection criteria while investing in such a complex decision as an ERP implementation. Top tree criteria were system functionality, technical aspect and the cost of the software (Baki and Çakar, 2005). Ranjan et al. (2018), believes that the operations and performance of the manufacturing company is very much dependent on the successful implementation of the ERP system. There are 25 critical success factors identified in the literature, however only 9 of them authors recognizing as the most important factors. These factors are change management, user need definition and expectation, IT infrastructure and architecture, performance measurement and evaluation, top management commitment and support, enterprise-wide communication, selection of the ERP software, user training and education, effective project management (Ranjan et al., 2018). New forms of organizations are based on close cooperation and networking. Manufacturing companies can increase the competiveness by implementing ERP systems (Raymond and Uwizeyemungu, 2007). Powell (2013) was questioning if ERP systems and lean manufacturing are complementary or contradictory technologies. Authors developed a framework presenting ERR in lean manufacturing production with six major areas: Combining lean and ERP for competitive advantage; Methods for the concurrent application of lean and ERP; ERP support for lean production; Real-time information for intelligent planning and execution; ERP systems for the extended lean enterprise; e-Kanban as a platform for integrating ERP and pull systems.

ERP & Supply Chain

Many companies have successfully implemented ERP systems and gained competitive advantage through the strategic usage of the software. According to Chen (2001) the success of the ERP implementation is primarily associated with an adequate planning prior to installation, careful selection of an ERP product, prioritizing business process and organizational requirements when adopting the ERP, economic and strategic justification. Chen (2001) realize the potential of ERP systems to develop from being a link between suppliers and customers, to become a mediator managing supply chain management and customer relations management. Kelle and Akbulut (2005), discussing how the supply chain is impacted by ERP tools. First of all, ERP is positively impacting the information exchange process within the supply chain, with the most positive effect on negotiation procedures. Secondly, there are procedures to select and aggregate the data to share with partners within the supply chain. Thirdly, there is an opportunity to optimize existing

business models and enhance cooperation (Kelle and Akbulut, 2005). Búrca et al. (2005), investigated the challenges faced by SMEs when implementing ERP systems. Authors stating that strategic technology adoption is demanding ERP coverage over the whole supply chain. Change management should be applied through the whole supply chain when adopting the ERP (Búrca et al., 2005).

According to Forslund and Jonsson (2007), it is very common to share a customer's demand forecast with suppliers. Consequently, the information flow is making an impact on the whole supply chain. The quality and the accuracy of the forecast could be very subjective, but the impact on the supply chain is inevitable. Li et al. (2009), analyzed the impact of IT implementation on supply chain integration and performance. According to the authors, IT offers accurate and reliable information that improving supply chain integration and supply chain performance. From the other hand, ERP system became very standard element of the business, which was initially designed to fulfil the internal needs of the organization, but not the entire supply chain (Akkermans et al., 2003).

Even if the ERP system successfully adopted in a strategic level covered the whole supply chain, it is still unclear what should be the best approach to measure the supply chain performance (Akyuz and Erkan, 2010). Akyuz and Erkan (2010), proposed metrics to measure the performance. One of the points is requiring an adoption of a proactive approach creating the platform for continuous improvement. Another interesting point is related to measuring partnership, collaboration, agility, flexibility, information productivity and ability to define business excellence. Bagchi et al. (2005), discussing the experiences of ERP integration by European manufacturers and establishment of electronic links with their supply chain. The study shows that only a few companies providing an ERP open access to their supply chain partners. Sharing sensitive data is still a barrier for many companies to lift relations with customers and suppliers on a strategic level trough transparency and online access. Very few companies are overcoming the barrier and establishing joint decision-making with their key suppliers and customers (Bagchi et al., 2005). High level of complexity within the supply chain is another barrier to achieve high performance. Giannakis and Louis (2011), proposing a framework to manage the complex supply chain system with a support of IT. Multi-agent model allows real-time adaptability with analytical tools that offering integrated decision-making framework. The focus of the framework is on supply chain demand rather than the forecast (Giannakis and Louis, 2011). Framework application supporting a better decision process in disruption and risk management within the manufacturing supply chain.

Conceptual Framework

Manufacturing companies are working on waste reduction and continuous improvement to create more value from the available resources (Womack et al., 1990). At the same time, manufacturers are a part of a supply chain in which collaboration procedures take up a lot of resources. The lean approach influenced the whole supply chain as one of the strategies competing with agile supply chain strategy or being combined in hybrid strategy (Lamming, 1996; Towill and Christopher, 2002). The supply chain was influenced by lean, because lean was not expected to be observed as an isolated process (Martínez-Jurado and Moyano-Fuentes, 2014; Naylor et al., 1999). Collaboration could reveal bigger opportunities to be leaner through the whole supply chain.

For several decades it has been very common to use the ERP system to plan and control the processes in manufacturing organizations (Palaniswamy and Frank, 2000). The literature describes both failures and successful implementation of ERP systems in manufacturing companies of different sizes and production focus (Baki and Çakar, 2005;

Duplaga and Astani, 2003; Yen and Sheu, 2004). The reasons for failure in adopting system are not technical. They are related to challenging business processes, poor strategic decisions and low human resources motivation to reach high performance through the adoption of an ERP (Ranjan et al., 2018; Raymond and Uwizeyemungu, 2007).

The whole supply chain represents a set of linkages between suppliers and customers, where ERP systems can play a significant role in this complex process (Búrca et al., 2005; Kelle and Akbulut, 2005). Information technologies are the source of flexibility and leading to optimize and simplify the information flow within the supply chain. IT also leads to improved suppliers' forecasts, accuracy, reliability of collaboration processes, and performance (Akkermans et al., 2003; Akyuz and Erkan, 2010; Forslund and Jonsson, 2007).

Previous studies also describe the importance of information technologies and digital tools, such as ERP systems to optimize the internal processes within the manufacturing organization as well as having limited or open access through the supply chain network to increase the performance. There are only a few studies investigating if manufacturing organizations can be leaner internally through supply chain collaboration and the active usage of technologies, such as ERP systems. The conceptual framework in Figure 1 was developed to understand the phenomena.

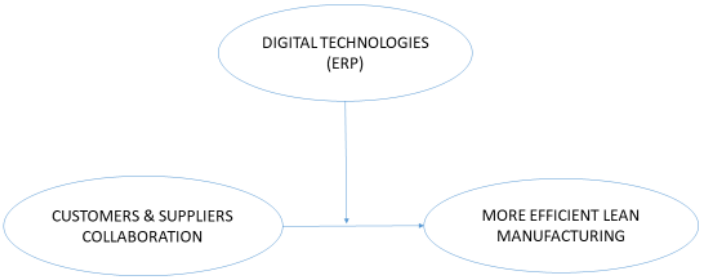

Figure 1 – Conceptual framework

Method

A multi-case study method was chosen as the approach to analyze the framework. The multi-case study allowed us to observe and analyze similarities and differences between the manufacturing companies that use ERP systems. The proposed framework include different scenarios with a hidden lean potential. The multi-case study method allowed us to observe the contrast between the companies that are using ERP system to collaborate with their customers/suppliers and the companies that are using the ERP system only within their organizations with no flexibility to collaborate on a digital level. Case research is a tool in the development of new theory and one of the most powerful research methods in operations management (Voss et al., 2002).The decision to choose two cases, was based on intention to increase the validity of the proposed framework (Caniato et al., 2018).

According to Handfield and Melnyk (1998), there are three stages of research in operations management. At the discovery (first) stage, companies were observed as a part of the Lean Management & Digitalization project plan. Semi-structured interviews were conducted with managers of the companies (CEOs, plant managers, IT managers, sales managers and etc.). In total there were 16 interviews and three workshops. Interviews were one to two hours long. The second stage was aimed at mapping and relations-building stage to find out common challenges or experiences the companies faced. At the final (third) stage, the framework was tested. The paper covers three key topics: lean manufacturing with a focus on waste reduction and continuous improvement, supply chain management with a focus on customer/supplier relations, and digital technologies with a focus on ERP systems.

Results

Company A & Customer/Supplier

Company A is an SME with a turnover SEK 42 million and 60 full-time employees. They want to be the most "customer-close" partner in the industry. The company is aiming to be the easiest to work with and to be perceived flexible and solution-oriented. Company A is working continuously to develop "customer value" by developing an internal process as well as common process and product. Lean-principal is the "baseline" in the company's job and working method such as continuous improvements, pulse meetings, and flow optimization are everyday concepts in the company.

Company A is a manufacturing company where the whole supply chain network is represented as a loop, where about 95% of all company orders are coming from the same customer who is providing all the raw materials for production. The raw materials are processed into aluminum frames and are delivered back to the customer to become a finished product. The company has no stock and is using JIT. The customer/supplier of Company A is a big company with complex infrastructure and long decision-making procedures based on organizational policies with a low flexibility to changes on a digital level.

Company A is actively using lean techniques to reduce waste and continuously improve their processes based on employees' feedbacks and observations. Company A has a whole potential to be lean internally, but very much dependent on their customer/supplier participation. For example, the raw material can be delivered in wrong color or size. Employees are quick in finding out a mistake and report about it. However, the response will take time. Purchase and quality managers from the customer/supplier side are working only day time. To fix the mistake might take the time of the whole shift. Company A would need to reschedule their activities and it will affect their productivity, efficiency, employee's satisfaction and the profit.

Company A is using in house developed ERP system that allows running the processes internally. Customer/supplier using the ERP which was closed for the access for any partners within the supply chain. Company A brainstormed how to improve their processes to leaner and *reduce the waste in time* when collaborating with a customer/supplier. Data transparency was recognized as the most powerful tool to reach the goal. Company A persuaded their key customer/supplier to share access to their stock and monitor the availability of the raw materials through the ERP systems communication. A total number of mistakes (e.g.: wrong material colors delivery) is reduced dramatically, according to managers' experience. Mistakes are classified since it is possible now to analyze the nature of the mistakes and develop scenarios to prevent them with an opportunity for *continuous improvement*.

Company B & Monitor ERP Systems AB

Company B has more than 16 high-quality CNC lathes managed by competent operators. The production handles everything from prototype and single-piece production to medium-sized series up to 40,000 pieces per year. The company has a complete department for post-processing, laser marking, grinding, honing, washing and tumbling. The high quality, flexibility, and efficient processes, create good profitability for Company B customers, with the least possible environmental impact. There is a special family spirit in the company where you allow differences and let people grow.

Company B have a large number of customers, however, most of the revenue is arriving from a few big companies. Company B is using the ERP system developed by Monitor, whereas their suppliers and customers are using different ERPs or software tools to run their internal activities. There is no digital interaction within the supply chain and data sharing process. Most of the information is shared by e-mail and often requires extra communication such as phone calls to prevent misunderstanding, delays or mistakes. There are cases when orders or demands of the customer are available to be downloaded from their websites. However, the information is in excel files and is not constantly updated or synchronized with stock and real needs. Any adjustments and changes are very time-consuming procedures affecting operations of Company B dramatically and creating waste in terms of time and reorganization of activities, human allocation, machine programming, and purchases of raw materials. Another interesting aspect is that every supply chain member is saving the data in a different format. When the information is spreader around the chain, Company B is always spending an extra time to convert (label) the products (data) in a format which is accepted to the ERP system for internal use. In other words, the whole supply chain is communicating different ‘digital languages’ and every time they are going thought the manual translation process, to keep the internal consistency and order.

Monitor ERP Systems AB was founded in 1974. Today's operations include Monitor business systems and consultancy services for manufacturing companies with a focus on SMEs. The company has more than 200 employees. The Monitor is currently installed at approximately 3,800 companies in over 30 countries and translated into 14 languages. In DataDIA's 2011 survey, Monitor had the highest customer satisfaction among the approximately 100 ERP systems in Sweden.

The Monitor is working in close collaboration with their existing and potential customers.The analysis lead Monitor team to extend the investigation of process beyond the borders of manufacturing plants. Since a lot of activities are based on collaboration, Monitor got interested in the supply chain of their customers. Putting Monitor customers on the map, managers realized that the vast majority of them are related to each other by being supplier of customers for their businesses. ERP developers established a feature called Monitor-to-Monitor (M2M). In a way, the ERP system created a buffer or ‘instant translator’ of the languages used by different companies using a Monitor ERP product. For example, when one send or receive an order or an order confirmation via e-mail in Monitor, an XML file is attached that the recipient can use in his/her Monitor system. One import/register the file by dragging and dropping it (using the mouse pointer) directly from the e-mail message to Monitor. There are also functions for maintaining basic data by sending and receiving part info, prices, lead times, annual volumes and suppliers' part numbers via e-mail. The only difference is that a TXT file is used for the import instead. Customers of Monitor found the feature as an extremely useful tool supporting their lean strategies. The main advantage is a reduction of waste in time, which was spent by different manufacturers to communicate. Another advantage is the opportunity for Monitor users to continuously improve their processes through the rapid data sharing and

the accuracy of the data synchronized with internal systems in local sides. Finally, the human factor as a valuable aspect of lean also was covered by M2M. Employees are more satisfied and feeling a better working environment by avoiding conflicts and trust issues when the data was lost or misinterpreted on the way causing financial losses.

Discussion

The frameworks developed (Figure 1) is proposing the idea of relations between customers and suppliers having a positive impact on lean manufacturing allowing the companies to be more efficient. The relations are stronger with the impact of digital technologies (Powell, 2013). This study is considering the ERP system as a digital technology. There is a lean potential in manufacturing company where the waste can be reduced, processes continuously improved, and the human factor can play one of the most significant roles in those activities. The processes of lean management is often quite isolated to let the improvements happen only within the manufacturing company. There is an approach to spread the lean management over the supply chain and let the customers and suppliers of manufacturing companies also to be leaner and more efficient during the collaboration process (Kelle & Akbulut, 2005). However, the hidden potential of the lean is also available to be explored and activated through the collaboration on a digital level (Akkermans et al., 2003), where each participant can benefit to become leaner (isolated) through the collaboration and use of technologies.

Unlocking lean potential with a connected ERP systems

The framework is supported by the Company A case where the hidden lean potential was identified and used. The company gained access to the customer/supplier ERP system (inventory) and improved the operations. Employees were able to independently predict and avoid many production mistakes by accessing customer/supplier inventory through the ERP systems communication. Based on managers' experience, the company reduced the waste of time and materials using the same resources with increased efficiency and profit. They also managed to continuously improve by rapid processes reorganization if the mistake in process flow was identified.

Unlocking lean potential with an unconnected ERP systems

The framework is supported by the Company B case, where the company realized the hidden lean potential through the digital interaction within the supply chain and data sharing process, though it is not functioning perfectly well yet. Company B can unlock the lean potential if they can connect the ERP system with their customers and suppliers. Data duplication, data confirmation by phone and e-mail, as well as data transformation in different formats are causing waste of time and duplication of action. Connecting the ERP systems with their customers/suppliers would also reduce this waste. If transparency were to increase, operation managers would have an ability to improve the actual production from the planning stage, using the most updated customer demands. Operations would be continuously improved and the human factor would play a key role.

Potential for further unlocking

Monitor, the ERP system developer, also support the framework developed, by extending the network of clients using the same ERP and offering functionalities simplifying data exchange procedures within the supply chain. Based on Monitor customer feedback when using connected ERP systems within the supply chain, the number of mistakes in orders has decreased. The ERP system guarantees transparency and accuracy, avoiding the waste of time and resources that previously happened due to the mistakes caused by having no ERP systems connected. Customer/supplier relations with connected ERP systems

improved continuously by better planning of orders with the real-time data availability about the inventory, machine operations and workload of employees.

Conclusion

This study contributes to the research of Powell (2013) in discussing the role and implication of ERP system in lean production. This study of Powell (2013) developed a framework presenting ERP in lean manufacturing production with six major areas. This paper contributes to at least two of the areas proposed by Powell (2013): ERP support for lean production and real-time information for intelligent planning and execution. The study also contributes to the research of Akkermans et al. (2003) discussing the need for flexibility through the IT within the supply chain.

This research presents a perspective for practitioners to extend or boost the hidden lean potential of manufacturing companies through supply chain digitalization. The study shows how manufactures can develop relations with their suppliers and customers through the active integration of ERP systems, which will allow them to become leaner as an isolated part of the supply chain. Collaborating more and increasing digital transparency with suppliers and customers enables companies to develop new opportunities to become more efficient and more profitable.

The study is limited to two cases of companies based in Sweden. The framework proposed needs to be validated with a bigger number of companies located in different countries. Lean manufacturing was only considered in three key aspects, such as continuous improvement, waste reduction, and the human factor. The study is limited by its very specific interpretation of lean manufacturing. For future studies, we suggest investigating what factors support successful collaboration between manufacturers, suppliers, and customers with usage of digital technologies to boost the hidden lean potential. Another direction for a future study is identification and validation of alternative digital technologies (besides ERP systems) supporting the framework.

References

Akkermans, H A., Bogerd, P., Yücesan, E. and Wassenhove, L.N. (2003), “The impact of ERP on supply chain management: Exploratory findings from a European Delphi study”, *European Journal of Operational Research*, Vol. 146, No. 2, pp. 284-301.

Akyuz, G.A. and Erkan, T.E. (2010), “Supply chain performance measurement: a literature review”, *International Journal of Production Research*, Vol. 48, No. 17, pp. 5137-5155.

Bagchi, P.K., Chun Ha, B., Skjoett-Larsen, T. and Boege Soerensen, L.B. (2005), "Supply chain integration: a European survey", *The International Journal of Logistics Management*, Vol. 16, No. 2, pp. 275-294.

Baki, B. and Çakar, K. (2005), "Determining the ERP package-selecting criteria: The case of Turkish manufacturing companies", Business Process Management Journal, Vol. 11, No. 1, pp. 75-86.

Búrca, S., Fynes, B. and Marshall, D. (2005), "Strategic technology adoption: extending ERP across the supply chain", *Journal of Enterprise Information Management*, Vol. 18, No. 4, pp. 427-440.

Caniato, F., Doran, D., Sousa, R., Boer, H. (2018), "Designing and developing OM research – from concept to publication", *International Journal of Operations & Production Management*, Vol. 38, No. 9, pp.1836-1856.

Chen, I. J. (2001), "Planning for ERP systems: analysis and future trend", *Business Process Management Journal*, Vol. 7, No. 5, pp. 374-386.

Christopher, M. and Towill, D. (2001), "An integrated model for the design of agile supply chains", International Journal of Physical Distribution & Logistics Management, Vol. 31, No. 4, pp. 235-246.

Christopher, M., Peck, H. and Towill, D. (2006), "A taxonomy for selecting global supply chain strategies", The International Journal of Logistics Management, Vol. 17, No. 2, pp. 277-287.

Duplaga, E. A. and Astani, M. (2003), “Implementing ERP in Manufacturing”, Information Systems Management, Vol. 20, No. 3, pp. 68-75.

Forslund, H. and Jonsson, P. (2007), "The impact of forecast information quality on supply chain performance", *International Journal of Operations & Production Management*, Vol. 27, No. 1, pp. 90-107.

Fritzen, S., Lefort, F., Lovera-Perez, O. & Sangen F. (2016, November). Digital innovation in consumer-goods manufacturing, available from: https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/digital-innovation-in-consumer-goods-manufacturing, last accessed <10.02.2019>.

Giannakis, M. and Louis, M. (2011), "A multi-agent based framework for supply chain risk management", *Journal of Purchasing and Supply Management*, Vol. 17, No. 1, pp. 23-31.

Goldsby, T. J., Griffis, S. E. and Roath, A. S. (2006), "MODELING LEAN, AGILE, AND LEAGILE SUPPLY CHAIN STRATEGIES", Journal of Business Logistics, Vol. 27, pp. 57-80.

Handfield, R.S. and Melnyk, S.A. (1998), ``The scientific theory-building process: a primer using the case of TQM'', *Journal of Operations Management*, Vol. 16, pp. 321-39.

Hou, F., Wang, A., & Wu, T. (2017, May). A digital upgrade for Chinese manufacturing, available from: https://www.mckinsey.com/featured-insights/china/a-digital-upgrade-for-chinese-manufacturing, last accessed <10.02.2019>.

Kelle, P. and Akbulut, A. (2005), "The role of ERP tools in supply chain information sharing, cooperation, and cost optimization", *International Journal of Production Economics*, Vol. 93–94, pp. 41-52.

Lamming, R. (1996), "Squaring lean supply with supply chain management", International Journal of Operations & Production Management, Vol. 16, No. 2, pp.183-196.

Leonard-Barton, D. (1990), ``A dual methodology for case studies: synergistic use of a longitudinal single site with replicatedmultiple sites'', Organisation Science, Vol. 1 No. 1, pp. 248-66.

Li, G., Yang, H., Sun, L. and Sohal, A.S. (2009), "The impact of IT implementation on supply chain integration and performance", *International Journal of Production Economics*, Vol. 120, No. 1, pp. 125-138.

Marodin, G., Tortorella, G., Frank, A. and Filho, M. (2017). "The moderating effect of Lean supply chain management on the impact of Lean shop floor practices on quality and inventory", Supply Chain Management: An International Journal, 22 (6), pp.473-485,

Martínez-Jurado, P.J. and Moyano-Fuentes, J. (2014), "Lean Management, Supply Chain Management and Sustainability: A Literature Review", Journal of Cleaner Production, Vol. 85, pp. 134-150.

McDermott, B. (2016, October). Digital Supply Chains: A Frontside Flip, Available from: https://www.thecge.net/dsci/, last accessed <10.01.2019>.

Muscatello, J. R., Small, M. H. and Chen, I. J. (2003), "Implementing enterprise resource planning (ERP) systems in small and midsize manufacturing firms", International Journal of Operations & Production Management, Vol. 23, No. 8, pp. 850-871.

Naylor, J.B., Naim, M.M. and Berry, D. (1999), "Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain", International Journal of Production Economics, Vol. 62, No. 1–2, pp. 107-118.

Palaniswamy, R. and Frank, T. (2000), "Enhancing Manufacturing Performance with Erp Systems", Information Systems Management, Vol. 17, No. 3, pp. 43-55.

Powell, D. (2013)."ERP systems in lean production: new insights from a review of lean and ERP literature", International Journal of Operations & Production Management, 33 (11/12), pp. 1490 – 1510.

Ranjan, S., Jha, V.K. and Pal, P. (2018), "Critical success factors in ERP implementation in Indian manufacturing enterprises: an exploratory analysis", Int. J. Business Information Systems, Vol. 28, No. 4, pp. 404–424.

Raymond, L. and Uwizeyemungu, S. (2007), "A profile of ERP adoption in manufacturing SMEs", Journal of Enterprise Information Management, Vol. 20, No. 4, pp. 487-502.

Towill, D. and Christopher, M. (2002), "The Supply Chain Strategy Conundrum: To be Lean Or Agile or To be Lean And Agile?", International Journal of Logistics, Vol. 5, No. 3, pp. 299-309.

Voss, C., Tsikriktsis, N., Frohlich, M. (2002), "Case research in operations management", *International Journal of Operations & Production Management*, Vol. 22, No. 2, 195-219.

Womack, J. P., Jones, D. T., & Roos, D. (1990). The machine that changed the World: The triumph of lean production. *New York: Rawson Macmillan*.

Yen, H. R. and Sheu, C. (2004), "Aligning ERP implementation with competitive priorities of manufacturing firms: An exploratory study", International Journal of Production Economics, Vol. 92, No. 3, pp. 207-220.