



Lean, Agile and Leagile Supply Chain Managements: A Review Study

Eyüp Anıl Duman¹, Mete Han Topgül², Hüseyin Avni ES³

Abstract

Companies should continuously pay attention in responding to the customer demand and improving the efficiency of their business processes in order to take part and survive in the marketplace. Profitability is another challenge for companies to stay in the market, reducing the cost of their product the best method for competitive price. Lean management is quite good method where demand is stable, predictable and low variety of customer requirement for reducing the cost. In volatile and high variety type of demand exist situations; agility management is required for profitable opportunities to compete in the market. Combining lean and agile management in the supply chain management area via the strategic use of a de-coupling point has been termed "Leagile Supply Chain Management". Therefore, companies have realized that leagility, the combination of the leanness and agility paradigms, is essential for their survival and competitiveness. For this reason, the studies related leagile supply chain management have been realized. The leagile strategy is a comparatively new strategy for the supply chain management. In this paper, lean and agile supply chain managements were examined with respect to time while leagile supply chain was presenting according to research methods.

Keywords: Leagile Supply Chain, Lean Supply Chain, Agile Supply Chain, Review

Introduction

Companies should continuously pay attention in responding to the customer demand and improving the efficiency of their business processes in order to take part and survive in the marketplace. The concept of leagility has drawn attention in recent years to gain competitive advantages. Leagility is the combination of the leanness and agility paradigms. Leanness means developing a value stream to eliminate all waste, including time, and to ensure a level schedule [1]. Lean is about doing more with less. Lean concepts work well where demand is relatively stable and predictable and where the customer requirement for variety is low. On the contrary, a much higher level of agility is required in those situations where demand is volatile and variety is high. Although leanness may be an element of agility in certain circumstances, it is not be able to meet the precise needs of the customers rapidly [2].

Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace [1]. Agility is being defined as the ability of an organization to respond rapidly to changes in demand, both in terms of volume and variety [3]. The lean and agile paradigms have been combined within successfully designed and operated total supply chains. The companies in the supply chain must deal with and exploit this volatility to their strategic advantage. In addition cost is another important market qualifier, and this is usually reduced by leanness. Combining leanness and agility in one supply chain via the strategic use of a de-coupling point has been termed "le-agility". Leagility is the combination of the lean and agile paradigm within a total supply chain by positioning the decoupling point so as to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the decoupling point [1].

The purpose of this paper is to introduce the concept of leagility integrating leanless and agile paradigms and present reviews of lean, agile and leagile supply chain managements.

¹ Eyüp Anıl DUMAN, Marmara University, Engineering Faculty, Department of Metallurgical and Materials Engineering , Istanbul, Turkey, anil.duman@marmara.edu.tr

² Mete Han TOPGUL, Pesico, Department of BIS-DMO, Istanbul, Turkey, metehan.topgul@pepsico.com

³ Hüseyin Avni ES, Karadeniz Technical University, Engineering Faculty, Department of Industrial Engineering, Trabzon, Turkey, avnies@ktu.edu.tr



Review of Lean Supply Chain Management

The discussion of lean supply was started by Lamming (1993). Then he expended his research with a new paper in 1996. Lamming mentioned that the lean paradigm can be applicable in many other areas and he listed characteristics of lean supply which will be followed by other researchers [4]-[5]. New and Ramsay (1997) made a comprehensive research about lean supply chain concept and they made suggestions for the future research [6]. Erridge and Murray (1998) researched within Belfast City Council to the feasibility of lean supply in local government purchasing [7]. Taylor (1999) described the Parallel Incremental Transformation Strategy (PITS) for an approach of the transformation of supply chain from traditional to lean [8].

In 2000s lean supply chain had more attention. McIvor (2001) determined the principles of lean supply model between an original equipment manufacturer and its key suppliers according to the dimension of design and joint cost reduction [9]. Fearne and Fowler (2006) mentioned the lean thinking in supply chain impacts on the industry effectiveness [10]. Part of Taylor (2006) researched was focused the developing an integrated lean supply chain in UK pork sector [11]. Another research in UK red meat sector was made by Cox et. al. (2007). They investigated the scope for lean strategies to be adopted in three red meat supply chains which are beef, lamp and pig [12]. Adamides et. al. (2008) developed the software tools for the design and management of lean supply network. They also discussed the knowledge and information management requirements of lean supply networks in their paper [13]. Wee and Wu (2009) studied a case from the Ford Motor Company to describe a lean supply chain (LSC) through value stream mapping (VSM). They also demonstrated lean supply chain affects product cost and quality [14].

After a decade, in 2010s, lean supply chain still has a important role between the others supply chain methods. Perez et. al. (2010) tested lean approaches in the Catalan pork supply chain [15]. Mollenkopf et al. (2010) made a literature review to examine the relationship among green, lean, and global supply chain strategies [16]. Zarei et al. (2011) integrated Analytic Hierarchy Process and Quality Function Deployment to enhance the leanness of the food supply chain [17]. Arlbjørn et. al. (2011) investigated the lean paradigm in a service supply chain management in the Danish municipal sector [18]. Martinez-Jurado and Moyano-Fuentes (2013) discussed the relationship between lean supply chain management and sustainability in a part of their review paper [19]. Chen et al. (2013) tried to find a solution for insufficient supply chain operations. They applied lean production and radio frequency identification (RFID) technologies to improve supply chain efficiency and effectiveness [20].

Review of Agile Supply Chain Management

Agile supply chain has emerged towards the end of the 1990s. Mason-Jones and Towill (1999) presented a route-map indicating the steps to be taken in achieving supply chain agility in real world [21]. Christopher (2000) proposed the conceptual framework of agile supply chain and discussed some applications [3]. Tolone (2000) studied on virtual situation room technology to provide agile supply chain [22]. Christopher and Towill (2002) proposed an integrated model for the design of agile supply chains [23]. Yusuf et al. (2004) discussed the nature of an agile supply chains and explored some of its attributes and capabilities [24]. White et al. (2005) investigated the role of emergent information technologies and systems in enabling supply chain agility [25]. Swafford et al. (2006) presented a framework of an organization's supply chain process flexibilities as an important antecedent of its supply chain agility [26]. Agarwal et al. (2007) proposed interpretive structural modeling to explore interrelationships of the variables in strategic planning for improving supply chain agility [27]. Song et al. (2007) studied on the agile supply chain management based on agent technology [28].

The papers related agile supply chains have increased year after year. Swafford et al. (2008) provided additional insights by testing hypotheses within a proposed conceptual framework of supply chain agility [29]. Jain et al. (2008) developed an approach based on fuzzy association rule mining for evaluating agility with both tangibles and intangibles characteristics in supply chain [30]. Baker (2008) studied on design and operation of distribution centres within agile supply chains [31]. Huang et al. (2009) developed a rough set-based generic label correcting algorithm which has agile approach in order to reduce the data/feature space in a



supply chain. Moreover, the four cases of the supply chain modeling are illustrated [32]. Luo et al. (2009) develop an information-processing model based on radial basis function artificial neural network for supplier selection in agile supply chains [33]. Riberio et al. (2009) presented an architecture supporting agile supply chains via service-oriented shop floor [34]. Braunscheidel and Suresh (2009) investigated the organizational antecedents of a firm's supply chain agility for risk mitigation and response [35].

Agile supply chain management has kept on its importance since 2010. Pearson et al. (2010) studied on process control in an agile supply chain network [36]. Wu and Barnes (2010) developed a model for the formulation of supply partner selection criteria in agile supply chain by applying both the Dempster-Shafer and optimisation theory [37]. Ji-peng et al. (2011) developed a prototype of the steel industry agile supply chain system with web service technology to achieve the supply chain agility and reconfigurability [38]. Ngai et al. (2011) developed a conceptual model based on the resource-based view to explore impact of the relationship between supply chain competence and supply chain agility [39]. Wang (2011) studied on dynamic coordination of framework and supporting platform design of the agile supply chain [40]. Costantino et al. (2012) proposed a technique for the strategic management of the chain addressing supply planning and allowing the improvement of the manufacturing supply chain agility in terms of ability in reconfiguration to meet performance [41]. Azevedo et al. (2012) proposed an index to assess the agility and leanness of individual companies and the corresponding supply chain. A case study in automotive industry was presented [42]. Ahn et al. (2012) discussed the use of extensible markup language for agile supply chains and proposed practical guidelines and future research directions for the field [43]. Vinodh et al. (2013) designed agile supply chain assessment model in order to assess the effectiveness of agile manufacturing. The computation was performed using fuzzy logic approach [44]. Liu et al. (2013) proposed a model to examine how information technology capabilities affect firm performance through absorptive capacity and supply chain agility [45]. Yusuf et al. (2014) assessed the link between dimensions of agile supply chain, competitive objectives and business performance in the UK North Sea upstream oil and gas industry via statistical techniques [46]. Yang (2014) developed a conceptual framework to investigate the antecedents of manufacturers' supply chain agility [47].

Review of Leagile Supply Chain Management

The term of legality firstly used by Naylor et al. in 1999. Both lean and agile paradigm combined with a total supply chain strategy. Naylor et al. explain each paradigm's definition and they also provided their comparison according to key characteristics. They put information by considering to manufacturing paradigms as supply chain strategies [1].

After the first published paper researchers had huge interest on the legile supply chain strategy and paper in 1999 was still in the top 15 most downloaded articles during July-September 2007 [48]. For investigate legality in supply chain; some researcher use comparative approach between three paradigms. Mason-Jones et al. (2000) classified supply chain design and operation depends on the actual needs of marketplace. The paper also gave a case study for each paradigm [49]. Agarwal et al. (2006) firstly specified performance determinant (lead time, cost, quality, service level) and made comparison between three strategies. Then they used the Analytic Network Process (ANP) approach to give the best supply chain type for the decision-makers [2]. Zhang et al. (2012) compared the traditional and leagile supply chain by using the system engineering concept. The paper chose the leagile strategy rather than traditional strategy by listing it's advantages [50]. Goldsbay et al. (2006) firstly described and reviewed all the three supply chain strategies. Then they examined supply chain performance according to three main aspects which are the expected level of customer service attainability, inventory and total cost [51]. Kisperska-Moron et al. (2011) picked a Polish distributor for a case study to compare mostly lean and agile supply chain strategy. Their paper also mentioned the legality is an example of transformation the lean/agile strategies according to market needs [52].

Picking a case study or special subject another approaches style for the researchers. Couple of them focuses on the food industry. van der Vorst et al. (2001) analyzed the poultry supply chain in Netherland with the customer order decoupling point (CODP). After their research they mentioned that leagility and decoupling



point very useful for analyzing supply chain but characteristic of food supply chain cause some restriction to applicability of them [53]. Rahimnia et al. (2009) investigated the fast food restaurant chains which are located in Iran. Their study has also shown that leagility concept is useful in supply chain but the application of it is restricted in fast food supply chain due to the health regulations in Iran [54]. Rahimnia et al. also continued their research in different area but still with a case in Iran. They picked up the second case in professional services. Their research analyzed the concept of leagility in healthcare services, especially hospitals in Iran [55].

The other specific sector is textile industry. Bruce et al. (2004) looked at three supply chain management approaches (lean, agile, leagile) used in the textiles and apparel sector. They used different type of companies for the cases and then they specified companies in textile and apparel need capability of quick respond to changing market demands [56]. Bruce and Daly also mentioned leagile supply chain management specifically on fast fashion in another research [57].

Many other researches mentioned leagility concept in supply chain management with different perspective. Soni et al. (2012) mentioned that lack of standard is a issue to create a structure of any supply chain paradigm. They reached that result by evaluating reliability and validity of lean, agile and leagile supply chain construct in Indian manufacturing industry. For the evaluation, they used two methods; first the literature of supply chain management is researched and second survey research is applied to the pillars of supply chain management network in Indian manufacturing industry [58]. Purvis et al. (2014) recently focused meaning of flexibility in the context of all three supply chain paradigms. Then integrated leagility concept to the supply network flexibility and analyzed it [59]. Mason-Jones et al. (2000) tried to answer the question "How can we integrated lean and agile paradigms to create leagile paradigm?". Their paper includes many comparisons between the lean and agile paradigms [60]. Herer et. al. (2002) offered different solution to achieve leagility in supply chain. They introduced transshipment with several examples as a fast and inexpensive approach in supply chain [61]. Chan et al. (2009) also offered solution but specifically scheduling problem in leagile environment. Their paper presented a leagile supply chain model for manufacturing industries and proposed Hybrid Chaos-based Fast Genetic Tabu Simulated Annealing (CFGTSA) algorithm to solve the problem [62]. Lastly, Ramana et al. (2013) noticed that there is a less attention on performance measurement and metrics pertaining to leagile supply chains and they developed a generic hierarchical model for performance measurement [63].

Conclusion

In the literature is seen that lean and agile strategies firstly used for manufacturing and production areas. After the 1990s, researchers found these strategies are applicable to many other area. This research identified the leagile paradigm which is combination of leanness and agility paradigms and reviewed other researches about all three strategies in the supply chain area. In this paper, lean and agile supply chain managements were examined with respect to time while leagile supply chain was presenting according to research methods.

The analyzed articles are divided according to their SCM methods and they are given as tables in appendix. The journals they appear in and the containing subject of each of them also given in appendix. Distribution of three supply chain strategies among the 63 articles which are analyzed in this research shown in Figure 1. The researchers' focus moving from the lean strategy (17 articles) to the agile strategy (28 articles) in time. Combining both strategies makes a new focus which is called leagile strategy (18 articles).

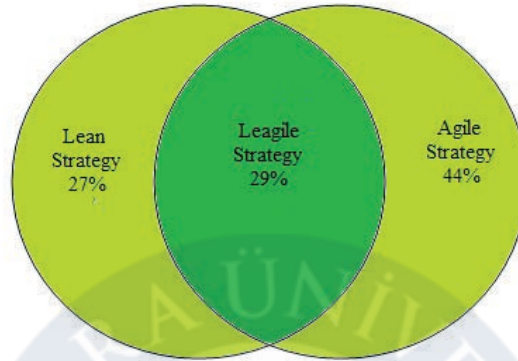


Figure 1. Distribution of Lean, Agile and Leagile strategies among the analyzed articles

The leagile strategy is a comparatively new strategy for the supply chain management. New attributes of leagility, applications of leagility in new sectors, new models for leagile supply chain are outstanding issues for the future research. Especially, transformation of supply chain from traditional, lean or agile to leagile should be addressed.

Besides that quality is important point to satisfy the customer demand, for this reason quality become a significant element in the supply chain management also. Therefore to remain in the competitive market, company's should care about the quality. In the Lean Supply Chain Management, quality is one of the main part, so it should not be think that quality is apart from the Leagile Supply Chain Management. But the companies how produced a good qualified supply chain management. In order to measure the quality in Leagile Supply Chain Management, metrics should be found, addressed and measured. If we call the "Qualeagile Metrics", some implementations should be done for these metrics in the market and published by the researchers.



Appendix

List of the analyzed articles subject to Lean SCM with a time order

Paper Name	Journal Title	Year	Subject
Beyond Partnership: Strategies for Innovation and Lean Supply	Prentice-Hall, Hemel Hemstead	1993	Lean
Squaring lean supply with supply chain management	Journal of Operations & Production Management	1996	Lean
A critical appraisal of aspects of the lean chain approach	European Journal of Purchasing & Supply Management	1997	Lean
The application of lean supply in local government: the Belfast experiments	European Journal of Purchasing & Supply Management	1998	Lean
Parallel Incremental Transformation Strategy: An Approach to the Development of Lean Supply Chains	International Journal of Logistics Research and Applications	1999	Lean
Lean supply: the design and cost reduction dimensions	European Journal of Purchasing & Supply Management	2001	Lean
Efficiency versus effectiveness in construction supply chains: the dangers of "lean" thinking in isolation	Supply Chain Management: An International Journal	2006	Lean
Strategic considerations in the development of lean agri-food supply chains: a case study of the UK pork sector	Supply Chain Management: An International Journal	2006	Lean
Stairways to heaven or treadmills to oblivion?: Creating sustainable strategies in red meat supply chains	British Food Journal	2007	Lean
Supporting collaboration in the development and management of lean supply networks	Production Planning & Control	2008	Lean



Lean supply chain and its effect on product cost and quality: a case study on Ford Motor Company	Supply Chain Management: An International Journal	2009	Lean
Development of lean supply chains: a case study of the Catalan pork sector	Supply Chain Management: An International Journal	2010	Lean
Green, lean, and global supply chains	International Journal of Physical Distribution & Logistics Management	2010	Lean
Food supply chain leanness using a developed QFD model	Journal of Food Engineering	2011	Lean
Service supply chain management: A survey of lean application in the municipal sector	International Journal of Physical Distribution & Logistics Management	2011	Lean
Lean Management, Supply Chain Management and Sustainability: A Literature Review	Journal of Cleaner Production	2013	Lean
Supply chain management with lean production and RFID application: A case study	Expert Systems with Applications	2013	Lean

List of the analyzed articles subject to Agile SCM with a time order

Paper Name	Journal Title	Year	Subject
Total cycle time compression and the agile supply chain	International Journal of Production Economics	1999	Agile
The agile supply chain	Industrial Marketing Management	2000	Agile
Virtual situation rooms: connecting people across enterprises for supply-chain agility	Computer-Aided Design	2000	Agile
An integrated model for the design of agile supplychains	International Journal of Physical Distribution and Logistics Management	2002	Agile



Agile supply chain capabilities: determinants of competitive objectives	European Journal of Operational Research	2004	Agile
The role of emergent information technologies and systems in enabling supply chain agility	International Journal of Information Management	2005	Agile
A framework for assessing value chain agility	International Journal of Operations and Production Management	2006	Agile
Modeling agility of supply chain	Ind. Mark. Manage	2007	Agile
Study on the agile supply chain management based on agent	The Journal of China Universities of Posts and Telecommunications	2007	Agile
Achieving supply chain agility through IT integration and flexibility	International Journal of Production Economics	2008	Agile
A new approach for evaluating agility in supply chains using fuzzy association rules mining	Engineering Applications of Artificial Intelligence	2008	Agile
The design and operation of distribution centres within agile supply chains	International Journal of Production Economics	2008	Agile
An agile approach for supply chain modeling	Transportation Research Part E	2009	Agile
Supplier selection in agile supply chains: An information-processing model and an illustration	Journal of Purchasing & Supply Management	2009	Agile
Supporting agile supply chains using a service-oriented shop floor	Engineering Applications of Artificial Intelligence	2009	Agile
The organizational antecedents of a firm's supply chain agility for risk mitigation and response	Journal of Operations Management	2009	Agile



Process control in an agile supply chain network	International Journal of Production Economics	2010	Agile
Formulating partner selection criteria for agile supply chains: A Dempster-Shafer belief acceptability optimisation approach	International Journal of Production Economics	2010	Agile
Interface Implementation of Manufacturing Industry Agile Supply Chain Nodes Based on Service Agent	Procedia Environmental Sciences	2011	Agile
Information technology, operational, and management competencies for supply chain agility: Findings from case studies	Journal of Strategic Information Systems	2011	Agile
The design of dynamic coordination architecture and supporting platform for agile supply chain	Procedia Engineering	2011	Agile
A model for supply management of agile manufacturing supply chains	International Journal of Production Economics	2012	Agile
An integrated model to assess the leanness and agility of the automotive industry	Resources, Conservation and Recycling	2012	Agile
Rethinking XML-enabled agile supply chains	International Journal of Information Management	2012	Agile
Design of agile supply chain assessment model and its case study in an Indian automotive components manufacturing organization	Journal of Manufacturing Systems	2013	Agile
The impact of IT capabilities on firm performance: The mediating roles of absorptive capacity and supply chain agility	Decision Support Systems	2013	Agile



A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry	International Journal of Production Economics	2014	Agile
Supply chain agility: Securing performance for Chinese manufacturers	International Journal of Production Economics	2014	Agile

List of the analyzed articles subject to Leagile SCM with a time order

Paper Name	Journal Title	Year	Subject
Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain	International Journal of Production Economics	1999	Lean + Agile + Leagile
Engineering the leagile supply chain	Production Management	2000	Lean + Agile + Leagile
Lean, agile or leagile? Matching your supply chain to the marketplace	International Journal of Production Research	2000	Lean + Agile + Leagile
Supply Chain Design in the Food Industry	International Journal of Logistics Management	2001	Leagile
Transshipments: An emerging inventory recourse to achieve supply chain leagility	International Journal of Production Economics	2002	Leagile
Lean or agile A solution for supply chain management in the textiles and clothing industry?	International Journal of Operations & Production Management	2004	Lean + Agile + Leagile
Modeling the metrics of lean, agile and leagile supply chain: An ANP-based approach	European Journal of Operational Research	2006	Lean + Agile + Leagile
Buyer behaviour for fast fashion	Journal of Fashion Marketing and Management	2006	Leagile



Modeling lean, agile, and leagile supply chain strategies	Journal of Business Logistics	2006	Lean + Agile + Leagile
Benchmarking leagility in mass services The case of a fast food restaurant chains in Iran	Benchmarking: An International Journal	2009	Leagile
Performance Optimization of a Leagility Inspired Supply Chain Model: A CFGTSA Algorithm based Approach	International Journal of Production Research	2009	Leagile
Supply chain leagility in professional services: how to apply decoupling point concept in healthcare delivery system	Supply Chain Management: An International Journal	2010	Leagile
On leanness, agility and leagile supply chains	International Journal of Production Economics	2011	Lean + Agile + Leagile
Improving supply chain performance to satisfy final customers: "Leagile" experiences of a polish distributor	International Journal of Production Economics	2011	Lean + Agile + Leagile
Research on Demand-driven Leagile Supply Chain Operation Model: a Simulation Based on AnyLogic in System Engineering	Systems Engineering Procedia	2012	Traditional + Leagile
Evaluating reliability and validity of lean, agile and leagile supply chain constructs in Indian manufacturing industry	Production Planning & Control	2012	Lean + Agile + Leagile
The development of a lean, agile and leagile supply network taxonomy based on differing types of flexibility	International Journal of Production Economics	2014	Lean + Agile + Leagile



References

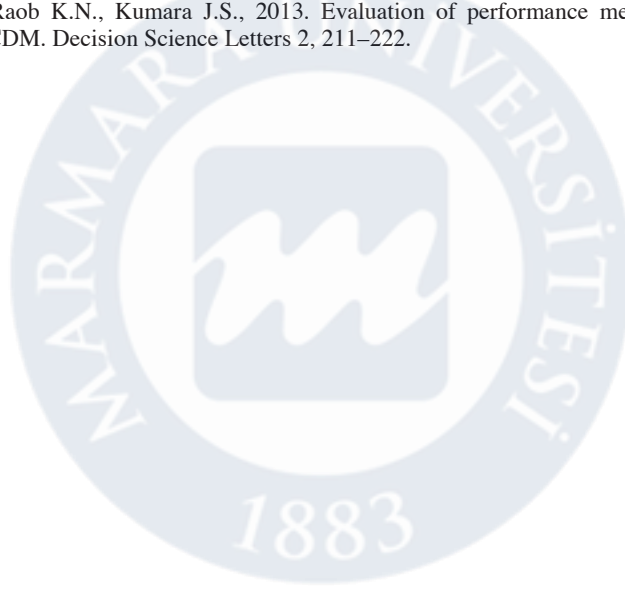
- [1] Naylor, J.B., Naim, M.N., Berry, D., 1999. Leagility: Integrating the lean and agile manufacturing paradigms in the total supplychain. *International Journal of Production Economics* 63, 107–118.
- [2] Agarwal, A., Shankar, R., Tiwari, M.K., 2006. Modelling the metrics of lean, agile and leagile supply chain: an ANP-based approach. *European Journal of Operational Research* 173, 221–225.
- [3] Christopher, M., 2000. The agile supply chain. *Industrial Marketing Management* 29, 37–44.
- [4] Lamming, R., 1993. *Beyond Partnership: Strategies for Innovation and Lean Supply*. Prentice-Hall, Hemel Hemstead, UK.
- [5] Lamming, R., 1996. Squaring lean supply with supply chain management. *International Journal of Operations & Production Management* 16 (2), 183–196.
- [6] New, S., Ramsey, J., 1997. A critical appraisal of aspects of the lean chain approach. *European Journal of Purchasing & Supply Management* 3(2), 93–102.
- [7] Erridge, A., Murray, J.G., 1998. The application of lean supply in local government: the Belfast experiments. *European Journal of Purchasing & Supply Management* 4(4), 207–221.
- [8] Taylor, D., 1999. Parallel Incremental Transformation Strategy: An Approach to the Development of Lean Supply Chains. *International Journal of Logistics Research and Applications* 2(3), 305–323.
- [9] McIvor, R., 2001. Lean supply: the design and cost reduction dimensions. *European Journal of Purchasing & Supply Management* 7 (4), 272–242.
- [10] Fearne, A., Fowler, N., 2006. Efficiency versus effectiveness in construction supply chains: the dangers of “lean” thinking in isolation. *Supply Chain Management: An International Journal* 11 (4) , 283–287.
- [11] Taylor, D.H., 2006. Strategic considerations in the development of lean agri-food supply chains: a case study of the UK pork sector. *Supply Chain Management: An International Journal* 11 (3) , 271–280.
- [12] Cox, A., Chicksand, D., Palmer, M., 2007. Stairways to heaven or treadmills to oblivion?: Creating sustainable strategies in red meat supply chains. *British Food Journal* 109 (9), 689–720.
- [13] Adamides, E.D., Karacapilidis, N., Pylarinou H., Koumanakos D., 2008. Supporting collaboration in the development and management of lean supply networks. *Production Planning & Control* 19 (1), 35–52.
- [14] Wee, H.M., Wu, S., 2009. Lean supply chain and its effect on product cost and quality: a case study on Ford Motor Company. *Supply Chain Management: An International Journal* 14 (5), 335–341.
- [15] Perez, C., de Castro, R., Simons, D., Gimenez, G., 2010. Development of lean supply chains: a case study of the Catalan pork sector. *Supply Chain Management: An International Journal* 15 (1), 55–68.
- [16] Mollenkopf, D., Stolze, H., Tate, W.L., Ueltschy, M., 2010. Green, lean, and global supply chains. *International Journal of Physical Distribution & Logistics Management* 40, 14–41.
- [17] Zareia, M., Fakhrzad, M.B., Paghaleh, M.J., 2011. Food supply chain leanness using a developed QFD model. *Journal of Food Engineering* 102, 25–33.
- [18] Arlbjørn, J.S., Freytag, P.V., de Haas, H., 2011. Service supply chain management: A survey of lean application in the municipal sector. *International Journal of Physical Distribution & Logistics Management* 41, 277–295.
- [19] Martínez-Jurado, P.J., Moyano-Fuentes, J., 2013. Lean Management, Supply Chain Management and Sustainability: A Literature Review. *Journal of Cleaner Production*, 1–17.
- [20] Chen, J.C., Cheng, C.H., Huang, P.B., 2013. Supply chain management with lean production and RFID application: A case study. *Expert Systems with Applications* 40, 3389–3397.
- [21] Mason-Jones, R., Towill, D.R., 1999. Total cycle time compression and the agile supply chain. *International Journal of Production Economics* 62 (1), 61–73.
- [22] Tolone, W.J., 2000. Virtual situation rooms: connecting people across enterprises for supply-chain agility. *Computer-Aided Design* 32, 109–117.
- [23] Christopher, M., Towill, D. R., 2002. An integrated model for the design of agile supplychains. *International Journal of Physical Distribution and Logistics Management* 31(4), 235–246.
- [24] Yusuf, Y.Y., Gunasekaran, A., Adeleye, E.O., Sivayoganathan, K., 2004. Agile supply chain capabilities: determinants of competitive objectives. *European Journal of Operational Research* 159 (2), 379–392.
- [25] White, A., Daniel, E.M., Mohdzain, M., 2005. The role of emergent information technologies and systems in enabling supply chain agility. *International Journal of Information Management* 24, 396–410.
- [26] Swafford, P.M., Ghosh, S., Murthy, N.N., 2006. A framework for assessing value chain agility. *International Journal of Operations and Production Management* 26 (2), 118–140.
- [27] Agarwal, A., Shankar, R., Tiwari, M.K., 2007. Modeling agility of supply chain. *Ind. Mark. Manage.* 36, 443–457.
- [28] Song, M., Fu, R., Zhu, C., Xin, Z., 2007. Study on the agile supply chain management based on agent. *The Journal of China Universities of Posts and Telecommunications* 14, 115–118.
- [29] Swafford, P.M., Ghosh, S., Murthy, N., 2008. Achieving supply chain agility through IT integration and flexibility. *International Journal of Production Economics* 116 (2), 288–297.



- [30] Jain, V., Benyoucef, L., Deshmukh, S.G., 2008. A new approach for evaluating agility in supply chains using fuzzy association rules mining. *Engineering Applications of Artificial Intelligence* 21 (3), 367–385.
- [31] Baker, P., 2008. The design and operation of distribution centres within agile supply chains. *Int. J. Production Economics* 111, 27–41.
- [32] Huang, C.C., Liang, W.Y., Lin, S.H., 2009. An agile approach for supply chain modeling. *Transportation Research Part E* 45, 380–397.
- [33] Luo, X., Wu, C., Rosenberg, D., Barnes, D., 2009. Supplier selection in agile supply chains: An information-processing model and an illustration. *Journal of Purchasing & Supply Management* 15, 249–262.
- [34] Riberio, L., Barata, J., Colombo, A., 2009. Supporting agile supply chains using a service-oriented shop floor. *Engineering Applications of Artificial Intelligence* 22, 950–960.
- [35] Braunscheidel, M.J., Suresh, N.C., 2009. The organizational antecedents of a firm's supply chain agility for risk mitigation and response. *Journal of Operations Management* 27 (2), 119–140.
- [36] Pearson, M., Masson, R., Swain, A., 2010. Process control in an agile supply chain network. *Int. J. Production Economics* 128, 22–30.
- [37] Wu, C., Barnes, D., 2010. Formulating partner selection criteria for agile supply chains: A Dempster–Shafer belief acceptability optimisation approach. *Int. J. Production Economics*, 284–293.
- [38] Ji-peng, W., Jing, X., Tian-lin, W., 2011. Interface Implementation of Manufacturing Industry Agile Supply Chain Nodes Based on Service Agent. *Procedia Environmental Sciences* 11, 111–117.
- [39] Ngai, E.W.T., Chau, D.C.K., Chan, T.L.A., 2011. Information technology, operational, and management competencies for supply chain agility: Findings from case studies. *Journal of Strategic Information Systems* 20, 232–249.
- [40] Wang, D., Zhao, Y., Wang, H., 2011. The design of dynamic coordination architecture and supporting platform for agile supply chain. *Procedia Engineering* 15, 3318–3322.
- [41] Costantino, N., Dotoli, M., Falagario, M., Fanti, M.P., Mangini, A.M., 2012. A model for supply management of agile manufacturing supply chains. *Int. J. Prod. Econ.* 135 (1), 451–457.
- [42] Azevedo, S.G., Govindan, K., Carvalho, H., Cruz-Machado, V., 2012. An integrated model to assess the leanness and agility of the automotive industry. *Resources, Conservation and Recycling* 66, 85–94.
- [43] Ahn, H. J., Childerhouse, P., Vossen, G., & Lee, H. (2012). Rethinking XML-enabled agile supply chains. *International Journal of Information Management*, 32, 17–23.
- [44] Vinodh, S., Devadasan, S.R., Vimal, K.E.K., 2013. Design of agile supply chain assessment model and its case study in an Indian automotive components manufacturing organization. *Journal of Manufacturing Systems* 32, 620–631.
- [45] Liu, H., Ke, W., Wei, K.K., Hua, Z., 2013. The impact of IT capabilities on firm performance: The mediating roles of absorptive capacity and supply chain agility. *Decision Support Systems* 54, 1452–1462.
- [46] Yusuf, Y.Y., Gunasekaran, A., Musa, A., Dauda, M., El-Berishy, N.M., Cang, S., 2014. A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry. *Int. J. Production Economics* 147, 531–543.
- [47] Yang, J., 2014. Supply chain agility: Securing performance for Chinese manufacturers. *Int. J. Production Economics* 150, 104–113.
- [48] Naim, M.M., Gosling, J., 2011. On leanness, agility and leagile supply chains. *International Journal of Production Economics* 131, 342–354.
- [49] Mason-Jones, R., Naylor, B. and Towill, D.R., 2000. Lean, agile or leagile? Matching your supply chain to the marketplace. *International Journal of Production Research* 38 (17), 4061–4070.
- [50] Zhang, Y., Wang, Y., Wu, L., 2012. Research on Demand-driven Leagile Supply Chain Operation Model: a Simulation Based on AnyLogic in System Engineering. *Systems Engineering Procedia* 3, 249–258.
- [51] Goldsby, T.J., Griffis, S.E., Roath, A.S., 2006. Modeling lean, agile, and leagile supply chain strategies. *Journal of Business Logistics* 27, 57–80.
- [52] Kisperska-Moron, D., Haan, J., 2011. Improving supply chain performance to satisfy final customers: “Leagile” experiences of a polish distributor. *International Journal of Production Economics* 133, 127–134.
- [53] van der Vorst, J.G.A.J., van Dijk, S.J., Beulens, A.J.M., 2001. Supply Chain Design in the Food Industry. *International Journal of Logistics Management* 12 (2), 73–86.
- [54] Rahimnia, F., Moghadasian, M., Castka, P., 2009. Benchmarking leagility in mass services: The case of a fast food restaurant chains in Iran. *Benchmarking: An International Journal* 16 (6), 799–816.
- [55] Rahimnia, F., Moghadasian, M., 2010. Supply chain leagility in professional services: how to apply decoupling point concept in healthcare delivery system. *Supply Chain Management: An International Journal* 15 (1), 80–91.
- [56] Bruce, M., Daly, L., Towers, N., 2004. Lean or agile: A solution for supply chain management in the textiles and clothing industry?. *International Journal of Operations & Production Management* 24, 151–170.
- [57] Bruce, M., Daly, L., 2006. Buyer behaviour for fast fashion. *Journal of Fashion Marketing and Management* 10, 329–344.



- [58] Soni, G., Kodali, R., 2012. Evaluating reliability and validity of lean, agile and leagile supply chain constructs in Indian manufacturing industry. *Production Planning & Control: The Management of Operations* 23, 864-884.
- [59] Purvis, L., Gosling, J., Naim, M.M., 2014. The development of a lean, agile and leagile supply network taxonomy based on differing types of flexibility. *International Journal of Production Economics* 151, 100-111.
- [60] Mason-Jones, R., Naylor, B., Towill, D.R., 2000. Engineering the leagile supply chain. *International Journal of Agile Management Systems* 2, 54-61.
- [61] Herer, Y.T., Tzur, M., Yucesan, E., 2002. Transshipments: An emerging inventory recourse to achieve supply chain leagility. *International Journal of Production Economics* 80, 201-212.
- [62] Chan, F.T.S., Vikas, K., 2009. Performance optimization of a leagility inspired supply chain model: a CFGTSA algorithm based approach. *International Journal of Production Research* 47 (3), 777-799.
- [63] Ramanaa D.V., Raob K.N., Kumara J.S., 2013. Evaluation of performance metrics of leagile supply chain through fuzzy MCDM. *Decision Science Letters* 2, 211-222.



MARMARA
ÜNİVERSİTESİ