Lean Manufacturing Practice and Business Performance in Multinational Supply Chain

Spasojevic Brkic Vesna, Tomic Branislav, Brkic Aleksandar, and Algheriani Saad Nuri

***Abstract*—Large number of companies benefits from the lean manufacturing practices, but lean practices in the supply chain context are rarely surveyed. Accordingly, the main aim of this survey is to analyze lean manufacturing practice and business performance in multinational supply chain. Survey comes to the conclusion that it is possible to classify and track lean manufacturing practice and business performance results of companies in multinational supply chain into pattern using multivariate statistics - factor and reliability analysis. It also shows that there exists positive and absolutely significant relationship.**

***Index Terms*—Lean manufacturing, business performance, multinational supply chain.**

I. INTRODUCTION

Contemporary competition moves beyond a single firm into the supply chain context. Companies interested to achieve essential advantage on the market, have to effectively leverage supplier relationships [1] and to choose suppliers that are high performers [2]. It is well known that supply chain members cannot act as independent members [3] but as supply chain partners that offer quality product that creates higher value for customers [4]. In that aim more academic research in the supply chain context is needed [5], [6] and this trend poses a major challenge for the future of the field of quality management [7]. Large number of companies benefits from the lean manufacturing practices and enhances firm performance in that manner [8]-[10], but lean practices in the supply chain context are rarely surveyed. Accordingly, the main aim of this survey is to analyze lean manufacturing practice and business performance in multinational supply chain.

II. PREVIOUS RESEARCH

Lean production is a management philosophy that focuses on reducing the seven identified types of losses (more recently, the eighth one - incomplete use of human resources is increasingly added), originally defined by Toyota [9]: overproduction, waiting times, transport, process, inventory, movement, and scrap. By eliminating losses, product quality is improved, production time is decreased and costs are declining. Lean techniques in essence serve to systematically identify and eliminate system losses, implement the concept of continuous flow and process retrieval by customers [9]. Among many Lean production tools, the three most typical are the inevitable in all efforts to achieve the Lean system: 5S, Kanban and Poka-yoke [9], [10]. Authors in [11] have compared the lean and agile manufacturing paradigms, highlighting their similarities and differences in supply chain context. They have concluded that neither paradigm is better nor worse than the other, but they are complementary within the correct supply chain strategy in [11]. Those findings are proved through real-world case studies in Mason-Jones *et al*. in [12]. Zhu & Sarkis in [13] have collected empirical results from 186 respondents in Chinese manufacturing enterprises and shown that lean manufacturing principles influence green supply chain management practices and performance. Taylor *et al.* in [14] have also proved that applying lean principles is improving the business performance of manufacturing operations and supply chain systems. Business performance is manifested through key performance indicators, which show the actual state in companies and possible deviations from the business objectives that have been set in [11], [15], [16]. Due to implementation of new practices it is necessary to track performance measures at company level. The most frequently studied types of performance in available scientific references are: quality performance, operational performance, market and financial performance, employee performance, customer satisfaction, innovation performance, project performance and aggregate firm performance [16]-[19]. Papers and research related to relationship between lean manufacturing and business performance are not frequently done, especially those one that analyze supply chain context. One of rare studies that has add to the body of knowledge on lean production supply chain in manufacturing industry is done by Agus *et al.* in [20]. Thus there is a need to define dimensions to enable research of relationship between lean manufacturing and business performance and to survey further that interrelation.

III. RESEARCH METHODOLOGY

Multinational supply chain subjected in this paper is formed around the world's leading manufacturer of both planes and trains with revenues of $16.3 billion in 2016. Company collaborates with a large number of worldwide reliable and steady suppliers. The whole supply chain is using Lean manufacturing concept in some extent. In the first phase of the study, the survey was e-mailed to all 87 multinational company manufacturing sites, and responses were received from 62 of the sites. Based on the responses received, during the second phase of the study, the worldwide suppliers of the companies participating in the first phase were contacted, and

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responses were received from 143 manufacturing supplier companies. The responses came in total from 200 companies settled on 6 continents in 32 different countries. Examined variables are shown in Table I.

TABLE I: VARIABLES EXAMINED IN THIS PAPER [9], [10], [12]-[14], [16]-[19], [23]

Construct	*Description*	*Abbreviation*
Lean Manufacturing	- Utilizing formalized 5S workplace organization methodology to create visual workplace Profit increase - Kanban concept usage as a scheduling system that precisely dictates what to produce, when to produce it, and how much to produce - Poka-Yoke model usage in a manufacturing process that helps equipment operator to avoid mistakes by preventing, correcting, or paying attention to known errors	LEAN1 LEAN2 LEAN3
Market and Financial Performance	- Increasing the number of customers - Profit increase - Increasing market share - Stable position in the market - Increasing return on investment	MARFIN1 MARFIN2 MARFIN3
Operational Performance	- Productivity increase - Deliveries on time - Cost reduction - Successful waste reduction program - Reduction of cycle times	OPER1 OPER2 OPER3 OPER4 OPER5
Employee Performance	- Increasing employees satisfaction - Decreasing absenteeism - Increasing salaries and benefits - Dedication of employees - Decreasing employee turnover rate	EMPL1 EMPL2 EMPL3 EMPL4 EMPL5
Investment and Development Performance	- Investment in research and development - Expansion of production capacities - Increasing the number of employees - Investment in the process / product innovation	INVDEV1 INVDEV2 INVDEV3 INVDEV4
Quality Performance	- Decreasing the number of nonconforming products - Continual processes / products improvements - Reduction of processes / products variability	QUAL1 QUAL2 QUAL3 QUAL4 QUAL5
Customer Satisfaction Performance	- Increasing customer satisfaction - Decreasing the number of customer complaints - Decreasing the number of warranty claims - Existence of loyal customers - Importance of the voice of the customers	CUSTSAT1 CUSTSAT2 CUSTSAT3 CUSTSAT4
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TABLE II: EXAMINED VARIABLES DESCRIPTIVE STATISTICS

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Lean Manufacturing	200	4.00	1.00	5.00	3.4867	.77210	.596
Market and Financial Performances	200	3.00	1.80	4.80	3.4050	.57114	.326
Operations Performances	200	2.60	1.80	4.40	3.3250	.51371	.264
Employees Performances	200	2.80	2.00	4.80	3.4230	.56254	.316
Investment and Development Performances	200	2.60	2.00	4.60	3.2590	.49795	.248
Quality Performance	200	3.40	1.40	4.80	3.6480	.67407	.454
Customer Satisfaction Performances	200	2.80	1.80	4.60	3.3980	.53199	.283

Examined variables descriptive statistics is given in Table II.

The best method to determine how many factors to retain is factor analysis [24], while Cronbach`s alpha is used as a measure of the reliability of a survey instrument [25]. The value 0.60 has been adopted for the lower level of Cronbach α acceptability and it is calculated according the formula given in Cronbach and Shavelson [26]. Explorative factor analysis is conducted using principal components with Varimax rotation and Kaiser normalization [27]. Only those factors that accounted for variances greater than one, i.e. with eigenvalues > 1, were extracted. Also, for interpreting the factors relating to sample size, only those items which had factor loadings greater than 0.4 were included in [28].

Reliability and factor analysis results are given in Table III, while correlation analysis is given in Table IV.hen you submit your final version, after your paper has been accepted, prepare it in two-column format, including figures and tables.

TABLE III: RELIABILITY AND FACTOR ANALYSIS

Construct	*Dimensions*	*Cronbach`s alpha*	*Factor Loading*
Lean manufacturing	LEAN1	.733	.756
	LEAN2		.843
	LEAN3		.826
Market and Financial Performance	MARFIN1	.804	.936
	MARFIN2		.903
	MARFIN3		.885
	MARFIN4		.848
	MARFIN5		.399
Operational Performance	OPER1	.815	.884
	OPER2		.949
	OPER3		.942
	OPER4		.745
	OPER5		.639
Employee Performance	EMPL1	.849	.908
	EMPL2		.851
	EMPL3		.640
	EMPL4		.929
	EMPL5		.693
Investment and Development Performance	INVDEV1	.879	.912
	INVDEV2		.945
	INVDEV3		.759
	INVDEV4		.795
	INVDEV5		.770
Quality Performance	QUAL1	.892	.901
	QUAL2		.830
	QUAL3		.897
	QUAL4		.859
	QUAL5		.711
Customer Satisfaction Performance	CUSTSAT1	.863	.825
	CUSTSAT2		.902
	CUSTSAT3		.908
	CUSTSAT4		.743
	CUSTSAT5		.893

TABLE IV: CORRELATION ANALYSIS

	Market and Financial Performances	Operations Performances	Employees Performances	Investment and Development Performances	Quality Performance	Customer Satisfaction Performances
Lean Manu-facturing	**.721****	**.529****	**.714****	**.350****	**.727****	**.766****
	p=0.000	p=0.000	p=0.000	p=0.000	p=0.000	p=0.000

IV. DISCUSSION AND CONCLUSION

This survey comes to the conclusion that it is possible to classify and track lean manufacturing practice business performance results of companies in multinational supply chain into pattern as described in this paper using multivariate statistics - factor and reliability analysis. It also shows that there exists positive and absolutely significant relationship between lean manufacturing practice and business performance results. There is a strong correlation between lean manufacturing practice and market and financial, employees, quality and customer satisfaction performance, while relationship between lean manufacturing and operations performance is weak. Investment and development performances and lean relation shows the worse results. Our results comply with those within the framework proposed in previous research done in other countries and contexts. The limitation of this study lies in the fact that this research is a cross sectional study. Future research could consist of a longitudinal study. Possible future research avenue is also wider description on lean manufacturing practice.

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