Prioritization of Lean-production Components with Fuzzy Network Analysis: A Case Study (Sam Electric Co.)

Sayyed Mohammad Reza Davoodi[1*], Fatemeh Pasamehr[2]
[1]Assistant Professor, Faculty of Management, Dehaghan Branch, Islamic Azad University, Dehaghan, Iran
[2]Ph.D. Student in Industrial Management (Subdiscipline of Financial), Dehaghan Branch, Islamic Azad University, Dehaghan, Iran
[*]Email of Corresponding Author: Smrdavoodi@ut.ac.ir
Received: November 11, 2019; Accepted: Februrary 15, 2020

Abstract
The purpose of this research is to comprehend the different dimensions of the concept of lean in order to identify activities proportionate to the economic, cultural and organizational conditions in the industrial environment of the country, which regarding them, the position of the focus company was measured in the direction movement of leaning. This research was conducted among 15 experts and managers of Sam Electronics Company, who were selected based on the Simple Random Sampling (SRS) method. To collect data in this research, a questionnaire was used. The effective indicators in the lean production system were ranked and evaluated after identification, utilizing the group decision-making model of the fuzzy network analysis method. The main indicators that were prioritized include; supply chain management (SCM), suppliers, timing production indicators, human resources management indicators, comprehensive quality management, and the indicators of Total Productive Maintenance. The sub-indicators of each of the primary indicators were also identified and prioritized, and according to the results of the research, necessary suggestions were made to move towards leaning and investment improving for each of the indicators.

Keyword
Lean Production, Fuzzy Condition, Network Analysis Process

1. Introduction

The study of lean-production literature shows that there is no consensus among authors and scholars on offering a specific definition for leaning or lean production. Further, some differences are also observed concerning the expression of the characteristics and specifications of lean manufacturing. The existence of this divergence can cause many uncertainties and ambiguities not only at the theoretical level but also likely to cause problems at the executive level to implement them in the companies. Also, in examining the models used in leaning assessment, it was found that this process has been significantly dependent on the thoughts/content of the researchers' opinions of each period. Therefore, it can be said that these models have been developed to either answer the questions or test the related assumptions and thus have their weaknesses and strengths [1].

Many companies have discovered the importance of leaning, and often they are doing lean working, without being lean in such groups, typically, many improvements are applied individually but are not linked to the overall organization's strategy. This is because lean management is a complicated process that interacts with several vital conceptual tools and therefore the use of it requires to get rid of the old patterns and installing new ones/models. Hence, an organization, at one stroke, cannot

moves towards lean production, but organizations must gradually apply the elements of lean manufacturing in a specific time-frame [2].
Currently, also at Sam Electrics Co., production planning in assembly lines of the LCD, LED TV has encountered with crucial issues in all processes with the occurrence of the slightest change in demands and change of the customers demand level despite the use of some lean manufacturing tools. These problems include high stock (parts) besides the production lines and warehouses, lack of sufficient space and poor layout of elements in repositories and excessive wastage, which increase the direct and production cost. The process of producing cabinets for televisions using press-and-duct machines as well as the entry of a large part of the main prices from abroad cause the problem of over-supply in the warehouses and besides production lines. Thus, it causes capital recession, destruction and damage to pieces/ parts due to long-term storage, excess storage costs, space shortages, and so on.
Therefore, the issue of achieving a lean manufacturing system has been proposed as an appropriate solution to these problems. We should choose a method for assessing lean production tools in order to provide the necessary guidelines for paving the way to leaning the lines of production as it is not possible to access all lean manufacturing tools and also putting in practice of complete lean production process, due to economic constraints and lack of full access to resources. In such a case, it is plausible to reach optimal production by using the minimum resources through the identification of the essential lean production devices. Doing so, it is possible to control the process of consuming the needed parts from the warehouse to the work/ operation station. Further, it is possible to carry out the production planning based on the provision of the customer's actual needs, not the foresight.
Considering the limitations and the importance of lean production, this research, with a proper understanding ofdifferent dimensions of the lean concept, aims at identifying the activities following the economic, cultural and organizational conditions in the industrial environment of the country. And finally, considering the actions assess the position of the company in question in the direction of leaning.

2. Theoretical Principles/ Framework

Lean production is a kind of manufacturing system that, while employing the benefits of mass production and custom manufacturing (handy), is designed to reduce waste and with the goal of eliminating activities without value-added [3].The central philosophy of this production system is to perfect and refine production systems. This method of production is called lean that consumes everything less in comparison to mass production. Lean production principles consider unlimited goals for the system. Some of these goals include a continuous decline in the cost price, zeroing wastes, a never-ending variety of products, and so on. In other words, this method of production is a complete system that uses the philosophy of continuous improvement and, utilizing the teamwork culture, attempts to decrease the losses in the production process and finally eliminate them. The features of such a system are a reduction in production time, efficient personnel performance, higher quality, more extended machines life and a decrease inthe stock level and overhead costs [4].The research background shows that lean production was initiated in 1960 in Japan. The idea pioneers we can name Eiji Toyoda, TaiichiOhno who, after the Second World War and till the

1990s, made a great deal of effort to create lean manufacturing bases. Later, over a period of 5 years, the Massachusetts Institute of Technology (MIT) with the help of production institutes and companies and costing over 5 million dollars, begun extensive studies in the recognition field of lean production. Then they have operated these activities in the framework of a plan called the International Motor Vehicle Program in 1985 [5].

3. Research Background

Majava and Ojanpera have been exploring the development of lean production in small and medium-sized companies. The results of their studies can contribute to creating knowledge in lean manufacturing. Also, managers in small and medium enterprises may use the results of this study as a reference at the time of designing production development projects [6].

AlManei et al. have evaluated the development of the global production framework applying Six-Sigma, overall/total production, maintenance and lean production. The results of their studies have shown that in order to achieve a global level and to achieve such a situation, it is necessary to have a single target to move so that it provides more opportunities for improvement [7].

Mrugalska and Ahram undertook a study concerning the fact that lean production has been widely populated and accepted in the industrial environment. The production process, continuous improvement and focus on value-added activities by avoiding wastes, is a paradigm that has just emerged in the manufacturing sector. This allows a smart grid to be built up of machines, products, components, properties, individuals and ICT systems throughout the value chain for having an original factory. In their study, they investigated small and medium-sized as well as extensive industries from the viewpoint of the factors for achieving lean production [8].

Prajapati and Deshpande in a study investigated the use of learning principles and techniques in reducing the cycle time. They highlighted the importance of this study as identifying the best tools and techniques for solving problems [9].

Sepahvand et al. have been exploring the participation in the global economy, global thinking is inevitable and implementation of management and production models in world-class is necessary. In today’s competitive world, one of the main concerns of top managers is the profitability and acquisition of sustainable results. One of the managerial models that recently and widely used in world-class firms is Lean Six Sigma (LSS) methodology. According to the growing use of the Lean Six Sigma program in the organizations of the country, the factors affecting the success of LSS in order to world-class production (critical factors, Support factors and related factors) have been analyzed in this paper. The study sample consisted of a top and middle managers in companies active in the household appliances industry in the Esfahan province [10].

Gupta and Kumar Jain explored the literature of lean production, stated that lean manufacturing requires the use of a wide range of tools and techniques as well as the selection of tools in a particular situation. To achieve organizational success, many of these lean manufacturing tools are needed to be implemented and performed by the organization. Companies that use lean manufacturing tools have better flexibility and market share. Further, lean production is an operational and cultural environment that minimizes production wastes [11].

Rahman et al. examined lean production by the implementation of the Kanban system and stated that senior management commitment, seller participation, stock management, and quality

improvement are significant for establishing Kanban and moving towards the lean manufacturing [12].
Gamage et al. examined the potential challenges and effects of lean manufacturing techniques performance in Sri Lanka's textile industry. They stated that the process improvement would reduce financial and non-financial benefits and also reduce the time is a critical factor in Operational costs decrease [13].
Dombrowski et al. investigated knowledge management in the lean manufacturing system. Their research results have shown that many different knowledge flows can occur during the implementation of the lean production system, and this is decentralized, and the role of a specific approach may help identify the appropriate method of knowledge management [14].
SolimaniNasab and Talebi examined an analysis of failure or success factors accessibility lean production system in Iran tire co.The aim of this paper analyzes the failure or success factors in achieving a lean production system in Iran Tire Co. has been done. To determine the rate of lean production systems, with research in books, articles, Internet resources, functions and areas initially were identified Lean Production. The results of this search, extraction and identification performance were 23 in seven areas were divided. Then, to assess and identify the current status of tire companies and determine the strengths and weaknesses and suggest some strategies for improving production systems to achieve a lean production system, was attempted. In the same direction as that under this assumption eight significant difference between the current situation in the company's production system with the demands of tire lean production system, in general, and in each domain separately, there is a plan and acceptable limits for acceptance hypotheses, the average higher than 4 were selected [15].
Simons and Taylor explored Lean thinking in the UK red meat industry.Food Value Chain Analysis (FVCA) based on the lean paradigm is being applied to eight value chains in the UK red meat industry. This paper is based on the forth chain involving value-added pork for a major retailer. Systems theory is used to evaluate FVCA based on four sub-systems—goals and values, logistics, human resources and management structure. The results show a positive potential logistics benefits along the chain, but identified two key implementation issues; inter-company alignment of other sub-systems and chain organizational stability through time [16].
Abdulmalek and Rajgupal describe a case where lean principles were adapted for the process sector for application at a large integrated steel mill. Value stream mapping was the main tool used to identify the opportunities for various lean techniques. We also describe a simulation model that was developed to contrast the “before” and “after” scenarios in detail, in order to illustrate to managers potential benefits such as reduced production lead-time and lower work-in-process inventory [17].
Shah and Ward examined the effects of three contextual factors, plant size, plant age, and unionization status, on the likelihood of implementing 22 manufacturing practices that are key facets of lean production systems. Further, we postulate four “bundles” of inter-related and internally consistent practices; these are just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM), and human resource management (HRM) [2].
The purpose of Ebadi et al.'s study is to present a new integrated approach based on EFQM model using Fuzzy Logic, Analytical Hierarchy Process (AHP) technique, and Operations Research (OR) model to improve the organizations’ excellence level by increasing the quality of business

performance evaluation and determining of improvement projects with high priority. A case study in Yazd Regional Electricity Co. in Iran is presented to demonstrate the applicability of the proposed approach. In a way that, primarily, performance assessment by the crisp method and the proposed method, the Fuzzy method, is carried out [18].

Purpose of the article TaghiZadeh et al. investigating the extent of acceptance of Iranian tractor manufacturing companies is based on pure thinking. Lean thinking is a solution for minimizing the costs and wastes and is a way to continuous productivity and value creation. Managers by deeply understanding this paradigm could use its techniques and make their firms ready forthe competition. For this purpose in this paper first, the theoretical background of lean thinking has been reviewed and its principles have been described. Afterward, a descriptive survey method has been used to inspect the adoption rate of Iran Tractor Manufacturing Company with lean thinking principles [19-20].

TolouiEshalaki et al. The indicators of effective lean production identified were prioritized using specified AHP indices. Then, for converting different measures with diverse dimensions and converts different relative importance to one single amount with no dimension, a dimensional analytical model was used. The figure resulted from the dimensional analytical model was compared to lean production global standard, and finally, after diagnosis of the gap between internal and external organizations, and offered a suitable model for minimizing the present and desired gap [21].

4. Methodology of Research

The research method used in this research directionally is applied, concerning goal, descriptive and regarding strategy is a survey Methodology.

In this research, the current status of the production of LEDs and LCD TVs was studied at Sam Electronics Co. To accomplish this, by using a questionnaire, the opinions of various experts of the production system such as material supply management, logistics, production planning, and control management, and warehouse management, engineering product, and documentary information in the company, identifying production planning issues, the implementation degree of leaning principles in the company or, in other words, leaning degree of a firm have evaluated. Then the lean production system employing the ANP network analysis technique was estimated to achieve a higher degree of leaning in the production process of the company.

In this study, the obtained scores, from the views of the workers, the operational experts, and the analysis results of questionnaires containing questions related to the components, sub-components, and elements of the lean production system, are given to experts in order to carry out their pair comparisons and announce their opinion. Then we calculated the weights of the pairwise matrices and used the FANP technique to evaluate the leaning degree of the company.

5. The Steps of the Algorithmsof Network Analysis

5.1 Step 1

Determination of the Lean Production Components of Sam Electrics (Figure 1)

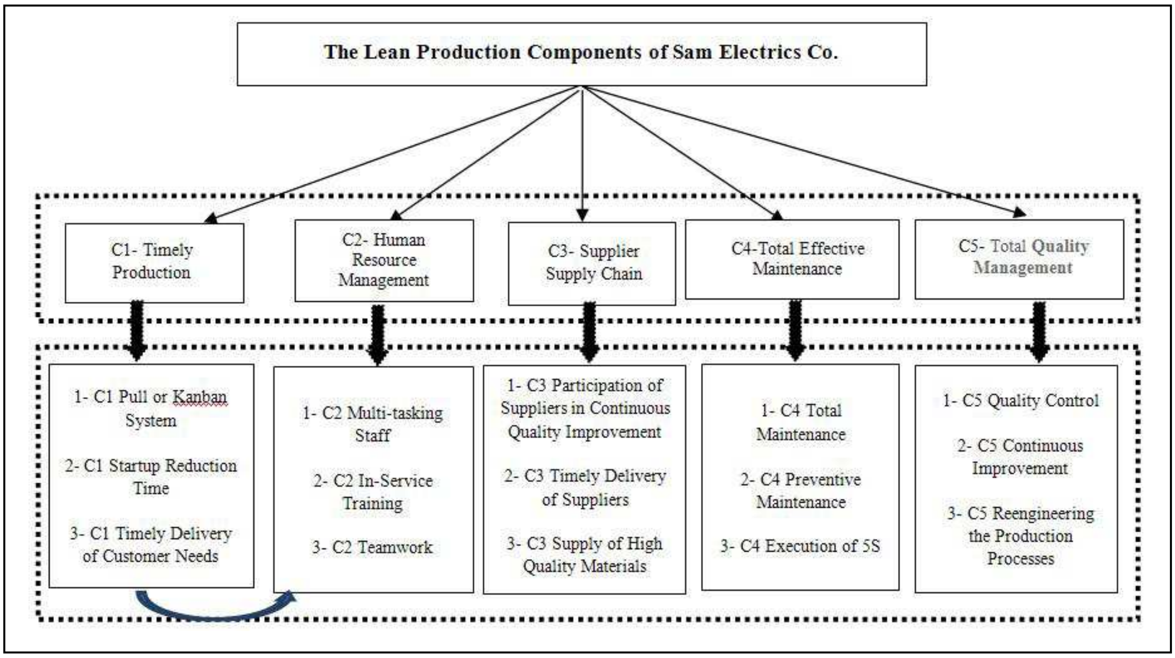

Figure1. Conceptual Model of Research (Source: Mrugalska and Ahram, 2017)

5.2 Step Two: Pair Comparison of the Primary and Subsidiary Factors

It is necessary to have a pairwise comparison between the given scores/points in order to obtain the weight of the main and its subset subsidiary factors. Therefore, each of the experts was provided questionnaires for each pairwise comparison of each element.

Summing up 15 experts opinion regarding the importance of C1 in relation to C2:

Assuming that K_i (l, m, u) = the idea of expert i regarding the importance of C1 toC2.

K1=(1,1.5,2), K2=(1,1.5,2),
K3= (1.5, 2, 2.5), K4= (2, 2.5, 3),
K5= (1.5, 2, 2.5), K6= (1, 1.5, 2),
K7= (1.5, 2, 2.5), K8= (1, 1.5, 2),
K9= (1, 1.5, 2), K10= (1.5, 2, 2.5),
K11= (1.5, 2, 2.5), K12= (2, 2.5, 3),
K13= (1.5, 2, 2.5), K14= (1.5, 2, 2.5),
K15= (1, 1.5, 2)

5.2.1 Calculating Geometric Mean of Total Comments Expert K

To perform pairwise comparisons in group mode, after obtaining the fuzzy pair comparative table for each expert, the following relation was applied to compute the composition of individual views and obtain the final tables of pair comparisons [22]:

$$\boldsymbol{Z_{ij}^{k}}=(\sqrt[k]{\mathbf{l_1 l_2 l_3 \dots l_k}}\ ,\ \sqrt[k]{\boldsymbol{m_1}\mathbf{m_2 m_3 \dots m_k}}\ ,\sqrt[k]{\boldsymbol{u_1}\mathbf{u_2 \dots u_k}} \qquad (1)$$

5.3 Step Three

Weighting the primary and secondary components

5.3.1 Defuzzification

In order to weigh components and sub-components, all entry of matrixes of done pair comparisons, which are as triangular fuzzy numbers, must be converted to absolute numbers. The methods used for this purpose generally are called defuzzification methods. The way of Defuzzification used in this study is the Center of Gravity method. In this technique, also called the center of mass, the surface gravity center of the subframe of the fuzzy membership function is determined as the definite value of the fuzzy number, which for this study, the center of gravity method (Surface Center,) is performed as follows:

In order to convert the fuzzy number $\tilde{M}$(l, m, u) = to the definite number, equation (2) has been applied, where l is the lower bound of the membership function, m the component with a greater degree of membership, and the upper bound of the membership function of the triangular fuzzy number.

After the defuzzification and integration of the experts' opinion, the matrix of the first direct relation of the aggregation, with definite numbers that represent the immediate effect of factor i on the element j, was formed.

$$+ \mathbf{l}\frac{(u-l)+(m-l)}{3} \qquad (2)$$

5.3.2 Weighting and Calculating the Consistency Rate

After converting fuzzy numbers to absolute numbers, Super Decision software was used to weight the matrices and calculate the consistency rate.

5.4 Step Four

Calculate the limited supermatrix

5.4.1 Formation of UnweightedSuper Matrix

Since all available comparison matrices in the UnweightedSuper matrix structure (A, B, C) are calculated and also their compatibility is controlled, the Unweighted Super matrix can be obtained by replacing these matrices with the primary supermatris, (Table 1)

Table1. Method of obtaining UnweightedSuper Matrix

Cluster Node Labels		**01 Goal**	**02 Main Components**					**3 Subcomponents C1**	
		Lean production	C1	C2	C3	C4	C5	C1-1	**C1-2**
01 Goal	Lean production	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
02 Main components	C1	0.257958	0.000000	0.314042	0.314799	0.268601	0.266006	0.000000	0.000000
	C2	0.130497	0.233706	0.000000	0.218150	0.217549	0.279308	0.000000	0.000000

	C3	0.212619	0.405863	0.260618	0.000000	0.349744	0.275358	0.000000	0.000000
	C4	0.135723	0.168396	0.206476	0.205758	0.000000	0.179328	0.000000	0.000000
	C5	0.263203	0.192035	0.218863	0.261292	0.164106	0.000000	0.000000	0.000000
3 Subcomponents C1	C1-1	0.000000	0.248926	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	C1-2	0.000000	0.280858	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

6. Findings

6.1 The Results of the Pairwise Comparisons of the Main Components

The results of the experiments carried out by the experts according to fuzzy calculations are presented in Table (2). The decision-making group consisted of 15 managers and experts. Thus the matrixes of pair comparisons are the result of a geometric mean of pairwise comparisons of 15 people.

As an example, after collecting the experts' responses regarding the importance of the factor C1 compared to C2, it was found that six experts believed C1 is less important than C2 and seven consider a greater significance for C1 and finally the other two experts have given C1 much more importance compared to C2. Then, to formulate the pairwise comparisons matrices for weighting the components, the geometric meanings of the comparisons were calculated as follows to reach the consensus of the expert's opinion.

6.2 Results of Calculating the Geometric Mean of 15 Experts' Total Comments

From the calculation of the geometric mean of the total opinions of 15 experts concerning C1 compared to C2, the values (1.32, 1.84, and 3.24) have been obtained.

Table2.Unweighted Supermatrix

		Goal	Main components					Subcomponents		
		Lean production	C1	C2	C3	C4	C5	C1-1	C1-2	C1-3
Goal	Lean production	0	0.258	0.13	0.213	0.136	0.263	0	0	0
Main components	C1	0	0	0.234	0.406	0.168	0.192	0.249	0.281	0.47
	C2	0	0.314	0	0.261	0.206	0.219	0	0	0
	C3	0	0.315	0.218	0	0.206	0.261	0	0	0
	C4	0	0.269	0.218	0.35	0	0.164	0	0	0
	C5	0	0.266	0.279	0.275	0.179	0	0	0	0
Subcomponents	C1-1	0	0	0	0	0	0	0	0	0
	C1-2	0	0	0	0	0	0	0	0	0
	C1-3	0	0	0	0	0	0	0	0	0
	C2-1	0	0	0	0	0	0	0	0	0
	C2-2	0	0	0	0	0	0	0	0	0
	C2-3	0	0	0	0	0	0	0	0	0
	C3-1	0	0	0	0	0	0	0	0	0
	C3-2	0	0	0	0	0	0	0	0	0
	C3-3	0	0	0	0	0	0	0	0	0
	C4-1	0	0	0	0	0	0	0	0	0
	C4-2	0	0	0	0	0	0	0	0	0
	C4-3	0	0	0	0	0	0	0	0	0
	C5-1	0	0	0	0	0	0	0	0	0
	C5-2	0	0	0	0	0	0	0	0	0
	C5-3	0	0	0	0	0	0	0	0	0

C5-2	C5-1	C4-3	C4-2	C4-1	C3-3	C3-2	C3-1	C2-3	C2-2	C2-1
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0.439	0.243	0.318
0	0	0	0	0	0.435	0.318	0.229	0	0	0
0	0	0.254	0.439	0.308	0	0	0	0	0	0
0.416	0.363	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

	C5-3	0	0	0	0	0	0.221	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

7. The Analysis of the Obtained Weights

Table 3 shows that the experts consider supply chain management as the most effective component in assessing the lean production system, after which the elements of timely production, human resources management, and total quality management, total effective maintenance system management play the most crucial role in the process of evaluating the lean manufacturing system respectfully. Further, the sub-component 3-C3, supplier quality assurance of materials, among all other sub-components, is the most effective sub-module in evaluating the system performance according to experts.

Table3. Final weights of each of the effective components and sub-components by the fuzzy ANP analysis method

Main components	Total weight of the main components-limited matrix	Final rate/grade	subcomponents	Total weight of the main subcomponents-limited matrix	grade in the category	Final grade
			C1-1	0.028274	3	10
C1	0.113585	2	C1-2	0.031902	2	8
			C1-3	0.053410	1	2
			C2-1	0.030302	2	9
C2	0.095370	3	C2-2	0.023204	3	13
			C2-3	0.041864	1	3
			C3-1	0.028246	3	11
C3	0.123136	1	C3-2	0.039113	2	4
			C3-3	0.055778	1	1
			C4-1	0.024583	2	12
C4	0.079932	5	C4-2	0.035083	1	6
			C4-3	0.020266	3	14
			C5-1	0.031960	2	7
C5	0.087977	4	C5-2	0.036567	1	5
			C5-3	0.019449	3	15

8. Conclusion

The occurrence of political, demographic, economic and cultural changes on the one hand, and the variety in consumer markets, the level of customer inclinations and the increase of industrial competition of the industries, on the other side, have led to significant revolutions in the manufacturing systems of industries in the 20th century. Undoubtedly, the organizations will overcome the challenges posed by these changes and will remain in the new competitive world that can adapt to these changes. Given that the principal focus of the industrial revolutions of the world is on the industrial production system, organizations must concentrate more on an adaptation of the principal focus with occurred changes. To achieve this, they need models that measure the degree of conformity of the production system with the changes and challenges posed by it; one of the manufacturing developments and revolutions of the industry in the world is the lean production. Consequently, the assessment and evaluation of the degree of adaptation of sectors with this revolution also require a model or models that will help them in this direction.

This research has been conducted to design a credible and scientific model for assessing the degree of leaning in the Sam electronics manufacturing system. In the designed model, the advantages of the available hierarchical structure between the components of lean production are applied, and the wished model has been designed. The quantitative outcomes of this model help the company's managers to periodically plan for leaning improvement and assess the status of their company's progression and weaknesses tangibly and comprehensively.

Another advantage of using this model is the identification of weak and strong domains among the leaning components in each industry, which can be used to present a suitable performance improvement pattern in order to raise the leaning degree for each unit.

The results indicate that in the process of production lines of LEDs, LCDs, supply chain management has the highest conformity with lean production, which suggests a more appropriate control of this factor than other factors. Total effective maintenance has the least match with lean production, which indicates the management weakness of this factor over other considerations. It is also observed that the main elements of supply chain management and timely production have the highest importance and an enormous impact on the leaning of the production line. Due to the high weight of these two factors, any increase in the quality of their subfactors, which makes them adapt to the leaning system, has significant effects on the movement of the product line to the point of leaning.

The results of the study of lean production factors in Sam Electronics Company are as follows:

The leaning of the production line depends on the five main elements; timely production, human resource management, communication with suppliers, total maintenance, and total quality control. Each of these five main factors has their sub-elements which impact on the leaning of production lines.

To approach lean production, priority is given to elements that are more important.

In short, the company can, by taking into account its specific organizational and environmental conditions, and by creating a reasonable balance, more efficiently utilize the benefits of each of the related activities and provide growth. The lack of a balance between these dimensions will dramatically restrict the organization from achieving its goals and even may transform them into a threat to the organization.

9. References

[1] JafarNejad, A., Ahmadi, A. andMaleki, M. H. 2011. Lean Production Evaluation using a Combination of Techniques ANP and DEMATEL in Fuzzy Conditions. Studies Industrial Management. 8(20): 1-25.

[2] Mirzai, M. andAkhundani,A.2015.A Review of Lean Production in Different Industries. Second National Conference on Industrial Engineering Research, Tehran, Bouali Research Group. 1: 15-22.

[3] Davari, D.2007. Different Attitudes to Production Management Systems in the Recent Decade. Tadbir, 106: 53-64.

[4] IzadMehr, J. andRahmani, F.2015.Estimation of the Implementation of a Lean Manufacturing System in Pars Co. Using SAE J4000 Standard. Third International Accounting and Management Conference, Tehran, MehrIshraq Contemporary Institute.

[5] Asadi, S., Qaraee, A. andPanahi, H.2011.The Factors of Lean Production in the Production Process of Dairy Milk Production. Journal Food Industry Research. 21(4): 495-511.

[6] Majava, J. andOjanper, A. T.2017.Lean Production Development in SMEs: ACase Study. Management and Production Engineering Review. 8(2): 41-48.

[7] AlManei, M., Salonitis, K. and Xu, Y.2017. Lean Implementation Frameworks: The Challenges for SMEs. Science Direct. 63: 750-755.

[8] Mrugalska, B. andAhram, T.2017. Managing Variations in Process Control: An Overview of Sources and Degradation Methods. Ergonomics Modeling, Usability and Special Populations. Advances in Intelligent Systems and Computing. 486: 377-387.

[9] Prajapati, M. R. and Deshpande, V.2015.Cycle Time Reduction using Lean Principles and Techniques: A Review. International Engineering, Industrial., 3(4): 208-213.

[10] Sepahvand, R., Arefnezhad, M. andToghraieSamiromi, M.2013.Attaining World Glass Production: Analyzing Factors Affecting Successful Implementation of Lean Six Sigma(Case Study: Household ApliancesIndustry). Journal of industrial management. 7(22): 71-82.

[11] Gupta, S. H. and Kumar Jain, S.2013.A Literature Review of Lean Manufacturing.International Journal of Management Science and Engineering Management. 8(4): 241-249.

[12] Rahman, N. A. A., Sharif, S. M. and Esa, M. M.2013. Lean Manufacturing Case Study with Kanban System Implementation. Procedia Economics and Finance. 7(1): 174-180.

[13] Gamage, K., Piyanka W., Jayathilake, L., Perera, H., Gamage J. R.2012.Challenges and Potential Impact of Applying Lean Manufacturing Techniques to Textile Knitting Industry: A Case Study of a Knitting Factory in Sri Lanka. Proceedings of 3rd International Conference: Engineering, Project and Production Management (EPPM2012), Brighton, UK.

[14] Dombrowski, U., Mielke, C. and Engel, C.2012.Knowledge Management in Lean Production Systems. 45th CIRP Conference on Manufacturing Systems. 3: 436- 441.

[15] SolimaniNasab, A. andTalebi, K.2010. Examined Analysis of Failure or Success Factors Accessibility Lean Production System in Iran Tire co. Journal Geography. 4(3):229-243.

[16] Simons, D. and Taylor, D.2007.Lean Thinking in the UK Red Meat Industry: A Systems and Contingency Approach. International Journal of Production Economics. Amsterdam Elsevier. 106(1): 70-81.

[17] Abdulmalek, F. A. andRajgupal, J.2007. Analyzing the Benefits of Lean Manufacturing and Value Stream Mapping via Simulation: A Process Sector Case Study. International Journal of Production Economics. 107: 223-236.

[18] Shah, R. and Ward, P. T.2003. Lean Manufacturing: Context, Practice Bundles and Performance. Journal of Operation Management. 21(2): 124-149.

[19] Ezzabadi, J. H., Saryazdi, M. D.and Mostafaeipour, A. 2015. Implementing Fuzzy Logic and AHP into the EFQM model for performance improvement: A case study. Applied Soft Computing, 36: 165-176.

[20] Taghizadeh, H., Tari, G. H. andAwrangi, S.2010. The Study of Adopting Rate of Production Organization with Lean Thinking Principles (Case study Iran Tractor Manufacturing Company-Tabriz). Journal of Industrial Management. 5(12): 41-52.

[21] TolouiAshlaghi, A., Motadel, M. R. andEhteshamRasi, R.2009. Presentation of an Analytical Model in Establishing Lean Production System (Case Study: Leather and Shoes Industry of Tehran Province). Researcher (Management). 6(13): 36-45.

[22] Ataei, M.2010. Multi-criteria Decision Making. Shahrood University of Technology Publication. 1: 118-126.