Cumhuriyet Üniversitesi Fen Fakültesi
Fen Bilimleri Dergisi (CFD), Cilt:36, No: 4 Özel Sayı (2015)
ISSN: 1300-1949

Cumhuriyet University Faculty of Science
Science Journal (CSJ), Vol. 36, No: 4 Special Issue (2015)
ISSN: 1300-1949

Identifying the key success factors (CSF) for the deployment of lean manufacturing techniques by using fuzzy TOPSIS (FTOPSIS) (Case Study: Iran Khodro Company)

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Received: 22.03.2015; Accepted: 29.05.2015

Abstract. The aim of this study was to identify indicators of lean manufacturing techniques by using fuzzy TOPSIS in Iran Khodro Co. The population of the study is 296 managers and experts of Iran Khodro and number of samples by using Cochran formula is 167. The deployment of lean manufacturing with the peer review literature in the form of a conceptual model in the 5 dimensions of leadership, management information systems, human resources, supply chain management and manufacturing process management, identification and screening of indicators 15 were in the index locating in each dimension. Then, using the technique of fuzzy TOPSIS to evaluation and ranking of indicators and techniques of lean manufacturing with Shannon entropy TOPSIS looked fuzzy. The importance of leadership in the rankings after the first and dimension information system management, manufacturing process management, human resources and supply chain management business ranks second to fifth respectively. Using fuzzy TOPSIS techniques and were rated 15 of the index's weight.

Keywords: Lean manufacturing, key indicators of success, fuzzy TOPSIS technique, Iran Khodro Company

1. INTRODUCTION AND STATEMENT OF PROBLEM

Lean manufacturing system solutions used in a very convenient and advanced. Lean System is one of the most advanced planning and control systems that are comprehensive and integrated management planning at the top of the other top systems have been produced. Necessary to compete in today's world, making use of all the techniques, tools and new ideas in the mode of production is pure. production while utilizing the benefits of mass production and manufacture of manual, non-value added activities to reduce waste and eliminate any based It is, in other words, production of goods and services to a number of essential, timely, high quality and production requirements and provides time and space (Sadeghiani et al., 2009). On this basis, the technically gifted with the help of their tools can have a fundamental role in improving the process. But do not say that all methods of lean production in all companies and factories are accountable and may lean production system of the company to another company and industry to industry and from situation to situation is different. The environmental studies and identify the needs of factories and companies are important. For this purpose, methods and lean manufacturing tools set (multi-purpose workers, Kanban, optimize the number of workers, intuitive control, Jay, two bars, SMED, 5 S, TPM, GT) and according to criteria such as running costs, increase quality, reduce waste, reduce inventory, increase employee contributions, reducing the amount of goods in process, reduce bottlenecks, respect for law and order .... Compare and ultimately the best lean manufacturing techniques are with regard to the need for a clear and grading plant (Ghanbartehrany, 2009). Because in the real world and definitely cannot be in many cases commented on the study of methods and criteria for the weighting of criteria to be considered as a linguistic variable. In many cases, the values of a quality criterion for the decision have not been clearly defined. In addition, the amount

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Special Issue: Technological Advances of Engineering Sciences

http://dergi.cumhuriyet.edu.tr/ojs/index.php/fenbilimleri

of satisfaction and weight the importance of each criterion is usually verbal phrases such as very high, high, medium and express (SH et al., 2003).

The aim of this study is the identification and ranking of key indicators of success for the deployment of lean manufacturing techniques fuzzy TOPSIS (FTOPSIS) Iran Khodro Company. The results of this study can Iran Khodro managers and senior experts in identifying indicators and help determine the importance of these indicators. The main research question is how to establish indicators of lean production in Iran Khodro Company should be considered by experts to participate?

2. RESEARCH BACKGROUND

Fazli and Gharamaleki (2001), in a study entitled: "prioritize waste and causes them to achieve lean manufacturing by using AHP" is. The study raised by AHP ranked in lean manufacturing. Ramezani research (2001), he plans to expand the scope of the technique and put it in the Lean manufacturing projects is analyzed. The merit of each stakeholder group is extracted from the literature. VSM also provides a framework for using the values of the interest groups in the project studied the lean production printing company. Motaghi and ayogh (2007), in a study titled, "Designing the path to the lean production model Jackson and Jones", the design process of implementing lean management in the companies' boards of Mazandaran ", the necessity of combining quality high, low cost, innovation, flexibility and delivery in the shortest time have found, according to the procedure and step by step systems of pure pattern is Jackson. Brothers et al. (1388), a study on the prioritization of JIT system components by TOPSIS method, to prioritize and select the desired JIT components Company TOPSIS method Pareto analysis and award criteria matrix coefficients entropy TOPSIS method is used at the end of the 5 components from 11 different parts of the system to run the company selected and their priorities are determined.

Table 1. Number of studies in recent pure.

researchers name	research title	The main purpose of research	original used model ((technique
CoA and model Et al. (2001)	JIT, TQM implementation relations And performance TPM	Determine whether to apply or not to apply techniques Explain the differences, TPM and JIT, TQM related to plant performance is observed?	- Analysis and confirmatory factor analysis (One-dimensional, convergent and divergent validity) - Correlated pairs - Test reliability of structures
Model King and enter (2003)	Lean Manufacturing: background, pure categories And TPM, JIT, TQM: Category And practice (HRM)	The importance of organizational aspects of good practice in the implementation of activities at the same time use pure lean operational performance	- Using hierarchical regression analysis Organizational performance (dependent variable) from independent variables such factors, pure categories, and industry
Model mortality and Forrester (2002)	Model to measure pure manufacturing companies in manufacturing companies	Testing claim "generalizability" using pure activities in Various industries and creating (DOA) to investigate the relationship between the use of lean production (DOL) real change in the direction of pure	- Correlation - Regression analysis
Sandayanakeh (and (et al. 2008	With JIT optimization systematic yield modeling and simulation approach	Using computer-based simulation and modeling tools linear mathematical techniques to identify key impacts on the performance of the production system when pure auto parts industry	The first phase is to determine the key drivers Modeling & (DOE) Phase II: pilot Phase III: modeling, simulation

3. METHODOLOGY AND RESEARCH MODEL

This study is part of research method descriptive with respect to the target, incentives and benefits among Transactional, because the results to adjust future plans of the Company (IKCO) will be used. The population consisted of 296 people in the car are production managers and experts. Managers and experts to determine the significance of the parameters (for experts) have benefited. Complete a management phenomenon requires a conceptual model is appropriate. Framework or conceptual model, the theoretical relationship between the variables of the study shows. The present study suggests the conceptual model of the relationships between variables. Chart 1 shows conceptual model.

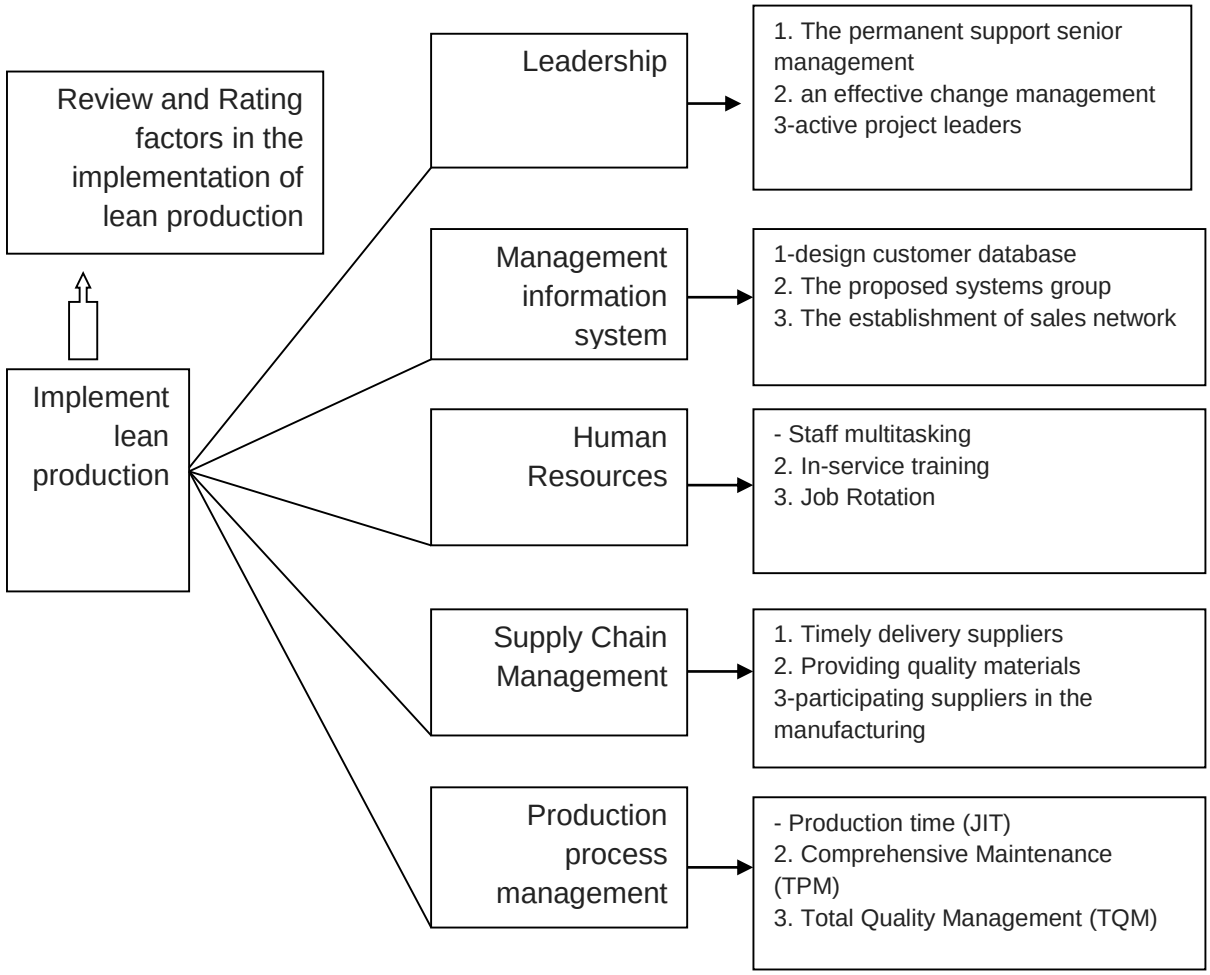

Figure 1. Conceptual model.

4. FINDINGS

4.1 calculate the weight of the lean manufacturing implementation after verification of the questionnaire survey (1) (validity and reliability), was distributed among 167 experts of Iran Khodro. After integration judgments using equation (11), the results of the implementation of lean manufacturing phase to get out of a table (2).

$$\tilde{w}_{ij} = \frac{1}{k}(\tilde{w}^{1}_{ij} + \tilde{w}^{2}_{ij} + \ldots + \tilde{w}^{k}_{ij}) \quad \text{Relationship (11)}$$

Table 2. Average of phased implementation of lean manufacturing.

Highlight Index	Description notation:	Phase out the importance of the Experts
L	**Leadership**	(0.35,0.7,0.8)
MIS	**Management information System**	(0.07,0.6,0.78)
HR	**Human Resources**	(0.06,0.35,0.72)
SCM	**Supply Chain Management**	(0.07,0.4,0.61)
PPM	**Manufacturing Process Management**	(0.06,0.63,0.7)

After obtaining the average weights phase implementation of lean manufacturing should Difuzzy fuzzy numbers (absolute) them. A variety of methods exist for certain of fuzzy numbers, such as the way out of the center. In the present study by the Centre for DVD fuzzy numbers are used. If a triangular fuzzy number, M = (a, b, c) Relation (12), how to calculate the final fuzzy numbers to show

Relation (12) $$CA = \frac{(c-a)+(b-a)}{3}+a$$

Table 3, the results of the calculation of the average of the absolute (Difuzzy) is implementation of lean manufacturing using the center of the show.

Table 3. Average importance of certain aspects of the implementation of lean manufacturing.

Highlight Index	Description notation:	Phase out the importance of Experts	The mean absolute importance (Dyfazy)
L	**Leadership**	**(0.35,0.7,0.8)**	**0.617**
MIS	**Management information System**	**(0.07,0.6,0.78)**	**0.483**
HR	**Human Resources**	**(0.06,0.35,0.72)**	**0.377**
SCM	**Supply Chain Management**	**(0.07,0.4,0.61)**	**0.360**
PPM	**Manufacturing Process Management**	**(0.06,0.63,0.7)**	**0.463**

Table 3, the results of the calculation of the average of the absolute (Difuzzy) is implementation of lean manufacturing using the center of the show.

Table 3: Average importance of certain aspects of the implementation of lean manufacturing 4.2 rating assessment of lean manufacturing with fuzzy TOPSIS after recognition of the importance of the main causes of weight gain and the phase distributed questionnaires to determine the number of times the weight of the lean manufacturing assessment And its placement with respect to the distance from the ideal solution was positive and negative. After collecting the questionnaires were EXCEL2013 software. The experts were of average weight. Table (4), the distance from the ideal of positive phase and a negative phase indicates the ideal solution.

Table 4. Positive and negative ideal solution.

Indices	L Leadership	MIS Management information System	HR Human Resources	SCM Supply Chain Management	PPM Manufacturing Process Management
FPIS	**(0.266,0.554,0.800)**	**(0.046,0.492,0.780)**	**(0.046,0.270,0.720)**	**(0.046,0.328,0.61)**	**(0.042,0.455,0.700)**
FNIS	**(0.055,0.233,0.392)**	**(0.013,0.202,0.320)**	**(0.009,0.117,0.353)**	**(0.014,0.135,0.250)**	**(0.013,0.223,0.301)**

4.2.1 Calculation of the distance of each of the options is ideal values the positive phase (di +) and negative (di-) Find every option of calculating the ideal solution both positive and negative findings, respectively, in Tables (5) and (6), said. For example, the distance (Leadership - a permanent support of the senior management) of the positive and negative ideal solution is:

(0.055, 0.248, 0.683) = normalized weighted decision matrix

A^+ = (0.055, 0.233, 0.392)

A^- = (0.266,0.554,0.80

$$\sqrt{(\frac{1}{3})\times(0.055-0.266)^2+(0.248-0.554)^2+(0.683-0.800)^2}=0.224$$

$d_1^+ = 0.224$

$$=^-d_1^- =\sqrt{(\frac{1}{3})\times(0.055-0.055)^2+(0.248-0.233)^2+(0.683-0.392)^2}=0.168$$

$0.168 =^- d_1$

Table 5. The indicators of positive ideal solution.

Index And Under Index	L Leadership	MIS Management information System	HR Human Resources	SCM Supply Chain Management	PPM Manufacturing Process Management	$\sum d_j^+$ Total distance
Permanent support senior management	**0.224**	**0.106**	**0.190**	**0.075**	**0.100**	**0.696**
An effective change management	**0.292**	**0.100**	**0.102**	**0.082**	**0.065**	**0.641**
The active participation of project leaders	**0.246**	**0.107**	**0.120**	**0.174**	**0.059**	**0.706**
Design customer database	**0.068**	**0.230**	**0.160**	**0.230**	**0.071**	**0.758**
The proposed systems group	**0.081**	**0.304**	**0.153**	**0.120**	**0.184**	**0.842**
Network sales system	**0.140**	**0.176**	**0.099**	**0.054**	**0.256**	**0.752**
Staff multitasking	**0.247**	**0.080**	**0.129**	**0.048**	**0.137**	**0.640**
Service training	**0.250**	**0.196**	**0.129**	**0.177**	**0.136**	**0.827**
Job Rotation	**0.115**	**0.202**	**0.105**	**0.136**	**0.042**	**0.600**
Delivery time supplier	**0.172**	**0.065**	**0.223**	**0.067**	**0.055**	**0.582**
Providing quality materials	**0.208**	**0.146**	**0.168**	**0.073**	**0.097**	**0.693**
Participating suppliers in the manufacturing	**0.223**	**0.106**	**0.060**	**0.102**	**0.100**	**0.592**
Production time	**0.176**	**0.100**	**0.014**	**0.106**	**0.065**	**0.461**
Comprehensive Maintenance	**0.185**	**0.113**	**0.081**	**0.072**	**0.059**	**0.509**
Total Quality Management	**0.168**	**0.143**	**0.147**	**0.063**	**0.066**	**0.587**

Table 6. The ideal solution negative indicators.

Index And Under Index	L Leadership	MIS Management information System	HR Human Resources	SCM Supply Chain Management	PPM Manufacturing Process Management	$\sum d_j$
Permanent support senior management	**0.168**	**0.251**	**0.044**	**0.161**	**0.168**	**0.791**
An effective change management	**0.047**	**0.213**	**0.130**	**0.155**	**0.239**	**0.784**
The active participation of project leaders	**0.079**	**0.207**	**0.110**	**0.062**	**0.210**	**0.668**
Design customer database	**0.272**	**0.084**	**0.077**	**0.013**	**0.207**	**0.653**
The proposed systems group	**0.291**	**0.018**	**0.077**	**0.165**	**0.085**	**0.637**
Network sales system	**0.192**	**0.211**	**0.140**	**0.215**	**0.019**	**0.777**
Staff multitasking	**0.107**	**0.279**	**0.102**	**0.209**	**0.199**	**0.859**
Service training	**0.080**	**0.123**	**0.101**	**0.148**	**0.134**	**0.585**
Job Rotation	**0.254**	**0.112**	**0.151**	**0.100**	**0.234**	**0.851**
Delivery time supplier	**0.153**	**0.260**	**0.018**	**0.185**	**0.212**	**0.828**
Providing quality materials	**0.127**	**0.174**	**0.062**	**0.167**	**0.188**	**0.718**
Participating suppliers in the manufacturing	**0.101**	**0.251**	**0.176**	**0.136**	**0.168**	**0.831**
Production time	**0.168**	**0.213**	**0.227**	**0.134**	**0.239**	**0.981**
Comprehensive Maintenance	**0.140**	**0.207**	**0.152**	**0.195**	**0.210**	**0.904**
Total Quality Management	**0.162**	**0.260**	**0.095**	**0.182**	**0.200**	**0.900**

4.2.2 Coefficients near and prioritize options

By determining factor near, the final step is to rank all the parameters can be started, and decision makers can choose the best indicators from various indices. Table (7), the results of the calculation of the factors affecting the implementation of lean manufacturing indices near rankings Displays For example, senior management index near permanent support is calculated as follows:

$$CC_1 = \frac{0.791}{0.696 + 0.791} = \quad 0.532$$

Table 7. Factors influencing the implementation of lean manufacturing index close.

Row	Indices	FPIS	FNIS	Close to the ideal ratio of positive (CCi)	Rank
1	Permanent support senior management	0.696	0.791	0.532	9
2	An effective change management	0.641	0.784	0.550	8
4	The active participation of project leaders	0.704	0.668	0.486	12
4	Design customer database	0.758	0.653	0.463	13
5	The proposed systems group	0.842	0.637	0.431	14
6	Network sales system	0.752	0.777	0.517	10
7	Staff multitasking	0.640	0.859	0.573	7
8	Service training	0.827	0.585	0.414	15
9	Job Rotation	0.600	0.851	0.5866	5
10	Delivery time supplier	0.582	0.828	0.5872	4
11	Providing quality materials	0.693	0.718	0.509	11
12	Participating suppliers in the manufacturing	0.592	0.831	0.584	6
13	Production time	0.461	0.981	0.680	1
14	Comprehensive Maintenance	0.509	0.904	0.640	2
15	Total Quality Management	0.587	0.900	0.605	3

Table (7), the index of production and maintenance during the first and second received is comprehensive. The rest received index ranks third to fifteenth.

5. CONCLUSIONS AND RECOMMENDATIONS

Table 8. Results of the index weighting and ranking implement lean manufacturing.

Under Indicators	Close to the ideal ratio of positive (CCi)	Rank
Production time	0.680	1
Comprehensive Maintenance	0.640	2
Total Quality Management	0.605	3
Delivery time supplier	0.5872	4
Job Rotation	0.5866	5
Participating suppliers in the manufacturing	0.584	6
Staff multitasking	0.573	7
An effective change management	0.550	8
Permanent support senior management	0.532	9
Network sales system	0.517	10
Providing quality materials	0.509	11
The active participation of project leaders	0.486	12
Design customer database	0.463	13
The proposed systems group	0.431	14
Service training	0.414	15

Table 8: Results of the index weighting and ranking implement lean manufacturing According to the results table (8), while ranking first production and other indicators rank second to fifteenth have won.

Suggestions for future research

1. Identify and prioritize the factors in the implementation of lean production in Iran Khodro and Saipa using techniques VIKOR, ANP fuzzy, ELECTRE, FAHP-TOPSIS.
2. The selection and identification of sub-components model, according to industry research
3. The application and design obtained in the present study, to implement lean manufacturing and improve it in any of the areas mentioned
4. The composition and design of the original model and agility achieved with other researchers and to provide a comprehensive model for the implementation of lean manufacturing-agile
5. More research on identifying opportunities to use this approach to other industries more efficient issues management concepts and management techniques, such as the theory of constraints, Six Sigma and lean manufacturing.

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