Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2015/01/jls.htm
2015 Vol.5 (S1), pp. 1329-1344/Safari and Soufi
Research Article

PRIORITIZE BARRIERS OF E-FACTORIES IN IRAN'S INDUSTRIES WITH HYBRID MULTI CRITERIA DECISION MAKING (MCDM) TECHNIQUES; (AHP-LLSM)

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ABSTRACT
The purpose of this research is to prioritize barriers of e-factories in Islamic Republic of Iran's industries with deterministic weight vector by logarithmic least squares method (LLSM) from paired comparisons matrix of analytic hierarchy process (AHP). Methodology of this research can be divided into three major sections. At the first step Identifying main barriers of establishing e-factory regarding questionnaire (A) information (specialized for experts of Industries in the Guilan province of Iran) and interview. At the second step completion questionnaire (B) for determining paired comparisons of factors affecting establishing of e-factory and calculate composed matrix. At the third step prioritizing barriers of establishing e-factory at country's industries with LLSM by LINGO software. Obtained weights shows that more than 60% of weights is devoted to the elements of management, human resources and organizational culture; these elements are counted as critical and key elements at implementation of e-factory.

Keywords: *e-Factory, Analytical Hierarchy Process (AHP), Logarithmic Least Square Method (LLSM)*

INTRODUCTION
In the Analytical Hierarchy Process (AHP), complex process issues into smaller components into a three-level hierarchical decomposition that at least one of the surfaces of paired comparisons matrix is formed. In general there is anything that compares n factor for decision-making in most cases requires (n (n-1)/2) comparisons are paired. It is important that the basis of matrix paired comparisons by experts that may not be compatible, and a deviation can effect on the final result prioritization (Buckley *et al.*, 2001). With study of the criticisms of AHP, categories the three major criticisms; include:

- Consistency criteria is not correct;
- Method of aggregation and integration weights of criteria and alternatives are not true;
- Saaty's procedure can be reversed to produce inaccurate ratings.

To the study of AHP applications and literature return to (Vaidya and Kumar, 2006). Most criticisms about AHP are its weighting. Golaney (1993) in comparative analysis of methods for measuring the paired comparisons matrix introduced 10 to 15 years, found that each of the applied methods have their advantages and disadvantages, and no single method is suitable for the weight issue (Bozoki, 2008). Kazutomo and Takahashi (2008) shown that the weighted least square (WLS) and the logarithmic least square (LLS) of various methods to solve the mutual evaluation network (MEN) system including the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP), are superior to others. Both methods can solve MEN problems without any restrictions of the structure matrix of MEN. They establish the error analysis of WLS and LLS. Especially, they give solving methods of MEN problems with different variances of errors by the WLS and the LLS.

This research results in a hybrid AHP-LLS method to prioritize the implementation of the fundamental issues of country to entry into the information society that called Computerized Integration Business (CIB). Research methodology can be divided into three major parts that has been done in the framework of diagram (1).

First step; includes identifying barriers and elements facing industries for establishing e-factory that is done based on the questionnaire (A). The result of this step is identifying indicators and effective factors. In order to determine validity of indicators Cronbach's Alpha has been used.
Second step; barriers and identified indicators will be ranked in previous phase that its data are obtained by using questionnaire (B).
Third step: ranked barriers and problems of previous step are prioritized.

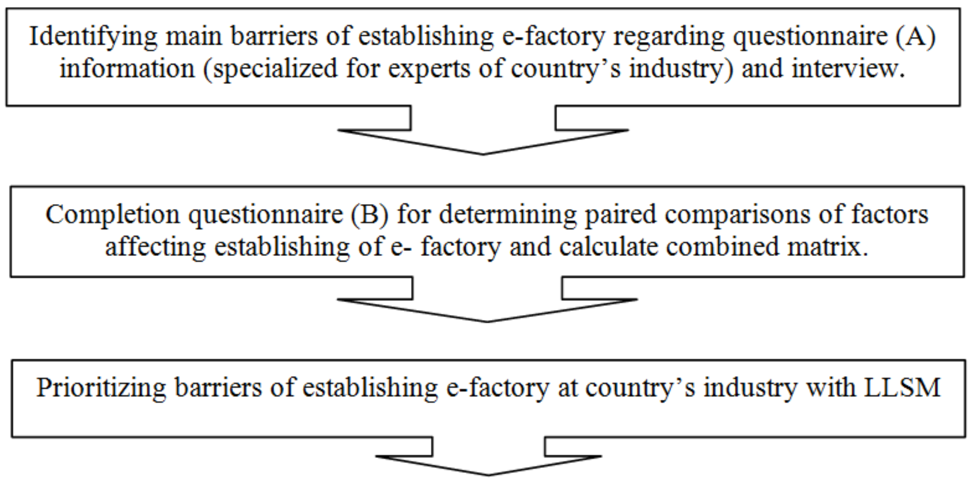

Diagram 1: Research design

Research Theoretical Framework
Considerable research hasn't been done about e-factory either in Iran or other countries; because e-factory doesn't have meaning alone and even if computerized integrated manufacturing (CIM) is implemented in Iran and other related solution sets establishes, we again can say that e-factory with considered operational concepts in this research, has been implemented; because e-factories are nodes of e-commerce network. The only collected study that is available in Library Studies is the book of "The roadmap to e-factory" (Beavers, 2001). Through preparation of the country for using communicative hardware and software entitled as IT, ICT and noticeable improvement of America and Europe in the field of making e-factory, it is time to consider barriers of implementing such factories and regarding country membership at world trade organization (WTO), we were prepared for connecting to computerized integrated business network (CIB).
It should be mentioned that about virtual factories various research and thesis especially in the field of computer and industrial engineering was written from the view of assimilation that have difference with e-factory in nature.

e-Business, e-Supply Chain and e-Factory
One of the terms that was long ago overworked but which is still useful is "e-business." The definition of e-business includes everything from the electronic facilitation of business transactions using the Internet to a whole new form of commerce based on "outside the box" strategic thinking about where Companies add value in their global supply chains. As a minimum, e-business is characterized by three adjectives: on-line, real-time, and interactive. On-line means that individuals and companies have computers that are actively connected to a network for a considerable portion of their decisions and transactions. Real-time means those individuals and companies are expecting answers to their inquiries or their communications within seconds. Interactive means that individuals and companies are conducting extended conversations, negotiations, or transactions while they are on-line.
When using a nodal network model for the supply chain, it is clearly seen that factories can be viewed as just a node in the e-supply chain. Inside this factory node are the business processes that must interact with the e-business facilitated external processes. As a result, each process in a factory must be e-business

oriented to satisfy the cycle time requirements, to operate within the network of supply chain nodes, and to provide the flexibility and speed required.

In summary, e-business is radically transforming business processes. Industries are dis intermediating because of e-business. Enterprises are rethinking where they add value and thinking about their industry as a network or assembly of component processes. As a result, there are significant transformations of entire industries and, more importantly, entire supply chains where there is a regrouping who owns the components and where they fit in the supply chain. E-Business is changing supply chains by changing the structure, the dynamics, and the economics of how large groups of companies work together.

The e-factory is the vertical dimension in the two-dimensional e-supply chain (figure 1). In simple terms, the e-factory is a new; all encompass term for all of the electronic control, automation, and intelligent machines that occupy today's factory environment. Electronic control of the factory has been growing in breadth and sophistication for the last two decades. With each new increase in performance and reduction in cost in computer technology, the factory environment comes under greater computer control.

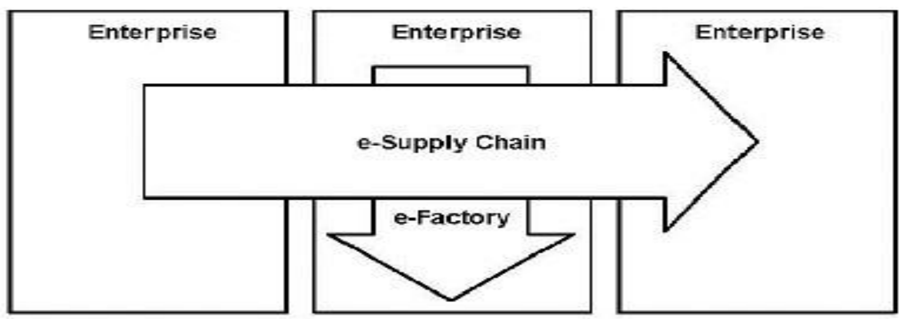

Figure 1: Two-Dimensional View of e-Business (Beavers, 2001)

What has happened in the last years is that there has been a rapid convergence of several trends in the factory. Computer technology has made it possible for every mechanical device in a factory to be intelligent and, therefore, interactive and real-time controllable. Supply chain management science has reached a point where there is philosophy and software that provide for planning policies that deal with short-term and long-term operation of a factory. And the rapid expansion of e-business has created a need for an entirely new set of management requirements for the factory and logistics systems.

A key element in developing a vision for the e-factory is having a model for how the factory can be controlled. Control architecture (see figure 2) needs to take into account where control functions are executed and the time requirements for these functions. Control architecture should consist of at least the following levels:

Factory Level

Refers to the highest level of control for the operations at a facility which could include more than one production line and more than one business process.

Line Level

Refers to a production line, focused factory through which flows material and information that results in the completion of a finished product or finished subassembly which is then deliverable to a customer or finished goods inventory.

Cell Level

Refers to a portion of a production line within which a variety of activities are performed. A cell can consist of one or more machines that work together or that are organized into a working area where a variety of activities are performed.

Machine Level

Refers to a piece of equipment used to perform or assist in the performance of a manufacturing activity on a unit of production.

Unit Level

Refers to a unit of production that could be a part, a subassembly, or a final assembly. This is the lowest level of the architecture.

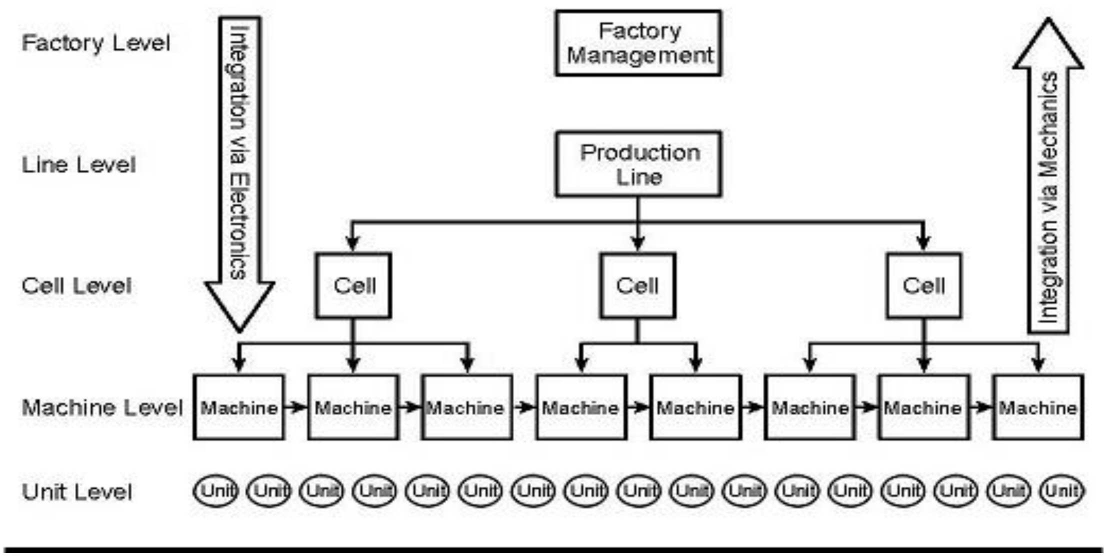

Figure 2: e-Factory Control Architecture (Beavers, 2001)

The simple description of the relationship of these levels goes as follows. A unit of raw material enters the first step of a production line. At the end of the production, a finished unit of production is completed and shipped to a customer or placed into a finished goods inventory. At each step in the production line, a machine operates on the unit of production. Several machines could be organized into a cell. A cell is necessary when there is a clear physical need to organize all the machines into groups. All the cells together form a production line. Within one factory, there could be more than one production line.

Expanding Automation at Production

Evolutional process of automation of manufacturing system has occurred during 4 steps of mechanization, dot automation, automation Islands and CIM (Harhen and Brown, 1984).

First step: mechanization

Automation of industrial units started with the thought of mechanical organization in which any member was given a set of repetitive and limited activities and was controlled by a hierarchical supervision (Browne, 1996).

Second step: Soft automation

Arrival of new control technology into factories in 1950s-1960s caused to use computerized and numerical control instead of manual control in some machines. This characteristic leads to flexibility at production that is the symbol of computerized automaton or so-called “soft automation”.

Third step: automation

Automation Island is formed by a set of integrated and automatic subsystems in a factory. In this step dot automation expand to adjacent operations.

Fourth step: The advent of CIM

Computer-integrated manufacturing (CIM) is the manufacturing approach of using computers to control the entire production process. This integration allows individual processes to exchange information with each other and initiate actions. Through the integration of computers, manufacturing can be faster and less error-prone, although the main advantage is the ability to create automated manufacturing processes. Typically CIM relies on closed-loop control processes, based on real-time input from sensors. It is also known as flexible design and manufacturing. The term "computer-integrated manufacturing" is both a method of manufacturing and the name of a computer-automated system in which individual engineering, production, marketing, and support functions of a manufacturing enterprise are organized. In a CIM system functional areas such as design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are linked through the computer with factory floor functions such as materials handling and management, providing direct control and monitoring of all the operations. CIM is most useful where a high level of ICT is used in the company or facility, such as CAD.CAM systems, the availability of process planning and its data (Bruce *et al.*, 2004).

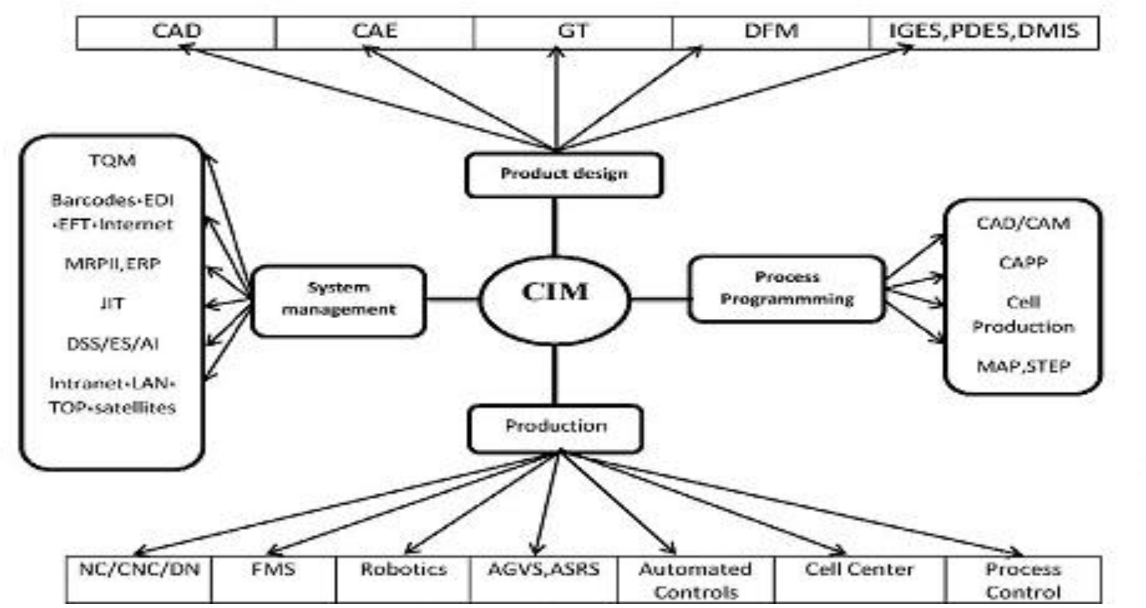

Figure 3: CIM Components (Harhen and Brown, 1984)

E-Factory Solution Set

E-Factory solution sets are evolving from several directions. Very specialized software companies have been formed and have rapidly evolved over the last few years. They have been serving distinctive needs in separate areas in the factory as islands of automation were installed throughout the factory. Many of these small software companies have since been acquired by larger systems integration and hardware companies. Manufacturing equipment companies that were started to serve specific process automation needs have now evolved to the point where they are trying to serve the needs of an integrated factory floor system. Process hardware companies are typically more concerned about getting the physics right in their manufacturing equipment and including only enough software to allow a human operator of the machine to be able to set up and operate the machine correctly. The technical evolution in the e-factory now requires that this equipment operate in a factory computer network and communicate with systems at higher control levels.

Systems integration companies, which initially began by providing the technical experts required to build interfaces between the different software packages and machine controllers that were necessary for a factory to operate electronically, have also begun to acquire software companies and offer solution sets for the e-factory market.

There is no off-the-shelf solution set that fits all, yet. ERP companies have advertised that they offer all the solution components that a manufacturing enterprise needs, but they do not, as yet, address the e-Factory. There are supply chain management software companies that are rapidly bringing new product features to market to address the business-to-consumer and business to- business market needs, but they too do not yet address the total e-Factory.

However, these products are rapidly evolving and it is important to be able to evaluate them when developing an e-factory roadmap. Solution set refers to a set of software and hardware components that provides the e-factory capability. These components might come from different software and systems suppliers or be provided by one supplier. The solution set must be able to execute, facilitate, and accelerate the internal business processes and the operational scenarios that define the way an e-factory should work. These components must also support and execute the interfaces with the other internal and external processes that exist in the e-factory.

Components of a Solution Set

The components of a solution set consist of hardware and software products whose operations cover all levels of the e-factory control hierarchy and both the vertical and horizontal dimensions in the supply chain.

The control levels are important because they provide a means of identifying what types of control are required, where they should be applied, and how they should be implemented.

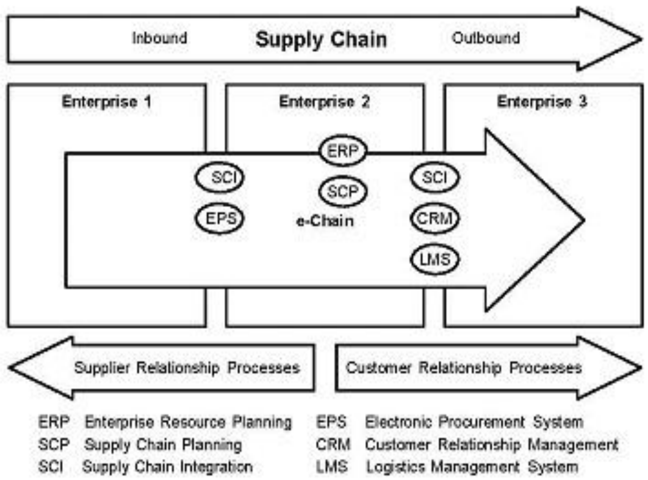

Figure 4: e-Factory Horizontal Solution Set Components (Beavers, 2001)

The horizontal components of an e-factory solution set (Figure 4) address the electronic supply chain, or "e-chain," requirements. They address the external business issues for the e-factory.

The vertical components of an e-factory solution set (Figure 5) address the requirements that are created by the need to support the internal process requirements and the interfaces to the e-chain solutions that different customers and suppliers might have.

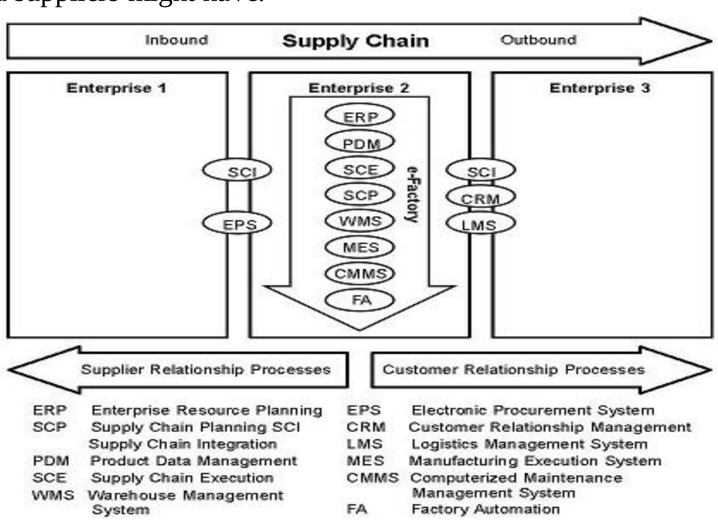

Figure 5: e-Factory Vertical Solution Set Components (Beavers,2001)

Totally research theoretical framework can be summarized as below:
The company's drive toward Computerized Integrated Business (CIB) is in direct response to the demands of its customers and the machine-tool and manufacturing-solutions marketplace.Today, a customer presents company with an application requirement and the company must design and manufacture a solution to fulfill that need. It has to deliver a total manufacturing solution: machine tools, material processing strategies, tooling, software, and a variety of ancillary equipment. Company is driving to become a computer-integrated business so it can provide those kinds of manufacturing solutions to its customers. Achieving CIB status means putting into place an integrated hardware, software, and networking scheme so information can flow seamlessly throughout the company.

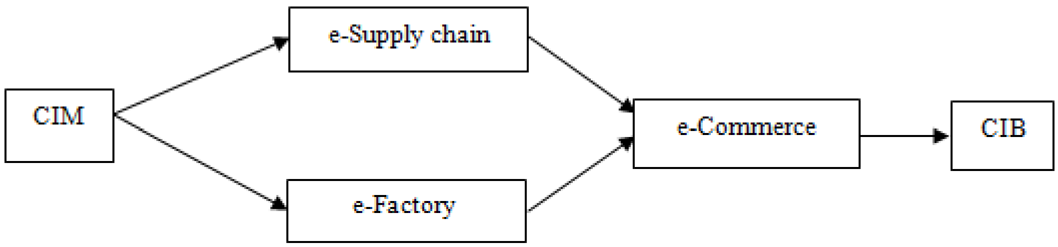

Figure 6: Research Theoretical Framework

Analytical Hierarchy Process (AHP)
This process is a multiple criteria decision-making methods (MCDM) that In order to make a decision and choose an alternative from among multiple alternatives to decide, according to an index that is used is determined by the decision maker. Analytical Hierarchy Process or AHP is a decision-making framework where by both subjective and objective measurements are taken into consideration to solve complex, multi-party criteria problems through the assessment of alternatives against an array of diverse objectives. That definition is based on a variety of sources and appears great when typed. The application of the process is defined in the Lockwood reading as an eight step progression. In other readings, they have compressed the process into four individual steps: 1.Decomposing, 2. Weighting, 3.Evaluating, and 4.Selecting.
Several methods have been proposed to obtain a certain weight vector:
1) The eigenvector
2) The averaged least square Method (ALSM)
3) The Logarithmic Least Square Method (LLSM)
4) The Weighted Least Square Method (WLSM)
5) The Geometric Row Mean (GRM)
6) Number of methods that only rely on some mathematical calculations Such as: matrix row average method which is normalized, normalized total rows and total columns reversed.

I. The eigenvector is well known and the most popular method, which was first proposed by Saaty (1980). This gives the solution by the eigenvector method, and is proved to be based on the mini-max principle by Frobenius (Sekitani and Yamaki, 1999; Sekitani, 2000). At first, this was used only for AHP, but later has become applicable to general mutual evaluation network (MEN) problems.
The method of eigenvector is the following:

$$W_i = \sum \frac{S_{ij} \times W_j}{n_i} \qquad (i = 1, \dots \dots n) \tag{1}$$

II. The ALS method is another method to make $\overline{w_i}$ near to w_i $(i = 1, \dots\dots, n)$, which isto minimize the sum D of squares of differences d_i of $\overline{w_i} - w_i$.

$$d_i = \overline{w_i} - w_i = \sum \frac{s_{ij} w_j}{n_i - w_i}$$

$$MinD = \sum d_i^2 \tag{2}$$

$w_1 + w_2 + \cdots + w_n = 1$

III. The LLS method is well known. Taking the logarithm of (1.2) we have

$\dot{w}_i - \dot{w}_j = \dot{s}_{ij} (\dot{w}_i = lnw_i, \dot{s}_{ij} = lns_{ij})$

$\dot{e}_{ij} = \dot{s}_{ij} - (\dot{w}_i - \dot{w}_j)$

$$\mathrm{MinQ} = \sum_{(j,i)\in E} \ln e_{ij}^2 = \sum [\ln s_{ij} - (\ln w_i - w_j)]^2 \quad (3)$$

$\ln w_1 + \cdots + \ln w_n = 0$

The LLS is a very natural method, and for an AHP with complete information, the solution of LLS is equivalent to that of the geometric mean method. This of course gives a positive solution, because exponential values obtained by the inverse transformation of logarithm are always positive.

IV. The WLS method is also a very natural method. The principle is very simple;

$e_{ij} = w_i - s_{ij} w_j$

$$\mathrm{MinQ} = \sum_{(j,i)\in E} e_{ij}^2 = \sum_{(j,i)\in E} (w_i - s_{ij} w_j)^2 \quad (4)$$

Nishizawa and Takahashi (2008) reviewed five methods for the mutual evaluation network system and find there may not be any other important ones except those five methods. For example, the geometric mean method is equivalent to the LLS (for the AHP with complete information) and the direct least square method ($Min \sum (s_{ij} - \frac{w_i}{w_j})^2$) may have multiple solutions requiring non-linear computations to be hardly useful. And they would like to insist that the LLS and the WLS method are superior to others.

In the AHP and the ANP field, the eigenvector method is the most popular and may be the most frequently used. The reason may be that this is the first method proposed by the renowned T. Saaty, the pioneer in these fields. But the LLS and the WLS can be applied to any problems of MENwithout any conditions.

The LLS and the WLS have almost the same merits, and also their analyzing processes are carried out by almost the same way. The difference is only the structure of errors.

MATERIALS AND METHODS

Research Methodology

First step

Regarding studies related to computerized integrated manufacturing (CIM) and its dependent components, also identification of roadmap to e-factory in theoretical studies, dimension and indicators of establishing e-factory has been identified.

Then through questionnaire that was designed for various industries' experts [Loshan Cement, Pars Khazar Rasht, Iran radiator, PegahGilan dairy industry, Javadiyancookies (Langroud), wood and paper industries (Chouka in Taalesh)] critical barriers and problems of establishing e-factory system was questioned in order to be prioritized based on their viewpoint (Table 2).

For testing reliability of the questionnaire questions of the interview, Cronbach's Alpha coefficient was used:

$$\alpha = \frac{n}{n-1}(1 - \frac{\sum s_i^2}{s_i})$$

Table 1: Result of calculating cronbach's alpha for determining reliability of the questionnaire

Description	Amount of cronbach's alpha	Type of questionnaire
Reliability of the questionnaire has been confirmed	0.9008	Questionnaire of industry's expert

Table 2: Element and barriers of implementing e-factory at Iran's industry

Inhibiting Factors	Barriers of implementing e-factory at Iran's industry(Alternatives)	Source
Management	• Rapid replacement of top managers due to their belonging to government.	• Soufi (2005)
	• Ruling of national vision instead of global vision in managers	• Brown (2002)
	• Lack of integrated information system of management at Iran's industries	• Soufi (2005)
	• Lack of strategies for keeping valuable human resources	• Ramsey (2003)
	• Lack of managers' mastery at economic and international strategic problems	• Alamro and Tarawneh (2011); Sarkar (2006); Ramsey (2003).
	• Inattention to capitals arrival and foreign capitalist to industry	• Kotwica, 2001; PriceWaterhouse Coopers, 1999; Lawrence, 1997; Quayle, 2002; Walczuch, 2000,
Human resources	• Lack of skilled workforce	• Auger, 1997.
	• Lack of flexibility of personnel against changes	• Rashid & Qirim ; 2001.
	• Lack of full awareness of personnel with description of their duties	• Kotwica, 2001.
	• Lack of personnel's commitment for achieving organization's goal	• Rashid & Qirim ; 2001
Organizational culture	• Lack of culture of group work at Iran's industry	• Poon and Swatman, 1997. Ling , 1999.
	• Lack of institutionalized criteria of control and quality improvement	• Nurdin, Stockdale and Scheepers , 2011.
	• Lack of client centric culture and paying attention to the voice of customers in Iran's industry	• Soufi, 2005.
	• Lack of culture of criticism and paying attention to the ideas and suggestions	• Bingi, 2000; SLBDC, 2002.
	• Lack of culture of constant improvement of industries	• Straeder, 2000; Smith, 2000.
Just In Time production(JIT)	• High degree of wastage at the process of manufacturing	• Johnston and Po Wan Lee, 1997.
	• High waiting time at response to inquiries	• Lokman and Winata, 2003.
	• High degree of work balance during production (WIP)	• Johnston and Po Wan Lee, 1997.
	• Lack of making correct relationship with suppliers of fragments and ingredients	• Kartiwi M. & MacGregor R., 2007.
	• Doing activities that don't have value added	

Total quality management	• Lack of using unerring systems at primary steps of design and production • Lack of organized feedback from customers about the quality of products and services • Lack of system of measuring and analyzing the quality of products and services • Lack of using originating control and inspection at production process • Lack of competitive atmosphere in most industries of Iran	• Auger, 1997; Price Waterhouse Coopers. (2000). • Zaied A., Al-Khairalla F. & Al-Rashed W., 2007. • Daya, 2012. • Alshehri M. & Drew S, 2010. • Soufi, 2005.
Technology	• Low level of technical knowledge at products' manufacturing • Existenceof political crisis effective on transmit of technology into country. • Lack of using computerized integrated manufacturing(CIM) method in all steps of designing and production • Lack of adaptation of input technology with conditions ruling industry	• Jacovou et al, 1995; El-Nawawy, 1999; OECD, 1998; Schmid, 2001; SLBDC, 2002; Cloete, 2002; Kirby, 1993. • Zaied A., Al-Khairalla F. & Al-Rashed W., 2007; Al jehail A, 2008. • Hourali M., Fathian M., Montazeri A. & Hourali A., 2008. Lawrence, K. L., 1997. Ramsey E., Ibbotson P., Bell J. & Gray D., 2003 • Scupola, 2003.
Manufacturing strategy	• Lack of explicit definition of production's goal • Ownership at Iran's major industries • Lack of attention to strategies of entering into global markets in written form • High cost of production • Time consuming of macro and micro decision making of country's industries	• Kirby et al., 1993 • Jacovou et al., 1995; Kirby et al., 1993; Looi, 2005. • Molla et al., 2005; Lawrence, 1997. • Kendall, 2001; Moore & Benbasat, 1991;Rogers,1995. • Soufi, 2005.

Second step

For ranking and prioritizing these elements, regarding their relationship, techniques of the process of AHP was used; therefore another questionnaire was designed that data of this questionnaire has been used as LLSM through inputs.

By prioritizing these barriers through LLSM, the problems of establishing e-factory were ranked. Final weight of each indicator was calculated through LINGO software.

Regarding quality of elements effective on factory establishment, for considering the influence of these elements on each other, Spearman ranking correlation coefficient was used.

$$r_s(X,Y) = 1 - \frac{6\sum_{i=1}^{1} d_i^2}{n(n^2-1)}$$

For the amount (n≤10) table of Spearman ranking correlation coefficient is used and for the amount (n≥10),r_s distribution is estimated with normal distribution.

For analyzing collected data of questionnaire and obtaining correlation coefficient, SPSS software was used that its result is presented in table (3) based on certainty level of 95%.

Table 3: The result of correlation coefficient between elements

	Management	Human resources	Production strategies	Just In Time Production	Production technology	Total Quality Management	Organizational Culture
Management	1	0.467	0.269	0.183	0.124	0.285	0.462
Human resources	0.467	1	0.183	0.269	-0.042	0.285	0.141
Production strategies	0.269	0.183	1	0.247	0.102	0.052	0.216
Just In Time Production	0.183	0.269	0.347	1	0.108	-0.020	0.460
Production technology	0.124	0.042	0.103	0.108	1	0.160	-0.029
Total Quality Management	0.285	0.285	0.052	-0.020	0.160	1	0.224
Organizational Culture	0.462	0.141	0.216	0.460	-0.029	0.224	1

Group composed matrices of paired comparisons about each group of different levels of AHP tree has been calculated separately for every element. Total composition of element is shown in table(4).

Table 4: Composed matrix of paired comparisons of elements effective on implementing e-factory system

	Management	Human Resourse	Production Strategies	Just In Time Production	Production Technology	Total Quality Management	Organizational Culture
Management	1	2.174	2.089	3.161	2.441	4.52	1.81
Human Resource	0.46	1	1.59	1.992	1.95	3.822	0.756
Production Strategies	0.478	0.625	1	2.314	0.812	3.37	0.52
Just In Time Production	0.316	0.502	0.432	1	0.478	2.004	0.29
Production Technology	0.41	0.513	1.234	2.091	1	2.89	0.44
Total Quality Management	0.221	0.261	0.296	0.498	0.344	1	0.366
Organizational Culture	0.552	1.32	1.935	0.370	2.28	2.730	1

Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at www.cibtech.org/sp.ed/jls/2015/01/jls.htm
2015 Vol.5 (S1), pp. 1329-1344/Safari and Soufi
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Table 5: Prioritizing barriers effective on implementation of e-factory system with AHP-LLSM method

W_i	Alternatives	AHP-LLSM prioritizing
0.4683072	Existence of political crisis effective on transmit of technology into country	1
0.3349209	Lack of personnel's commitment for achieving organization's goal	2
0.3222912	Lack of client centric culture and paying attention to the voice of customers	3
0.2935627	Lack of making correct relationship with suppliers of fragment and ingredients	4
0.2824459	Lack of competitive atmosphere in most industries	5
0.2776973	Lack of institutionalized criteria of control and quality improvement	6
0.2741321	Lack of full awareness of personnel with description of their duties	7
0.263238	Time-consuming of macro and micro decision-making	8
0.2494629	Lack of flexibility of personnel against changes	9
0.2313425	Ownership in the industry	10
0.2299939	Lack of using computerized integrated production	11
0.2257989	Rapid replacement of top managers due to their belonging to government	12
0.2226473	High cost of production	13
0.2158627	Lack of managers' mastery at economic and strategic problems	14
0.2046002	Doing activities that don't have value added	15
0.1981498	High degree of work balance during production	16
0.192223	Lack of organized feedback from customers about the quality of products	17
0.1897404	Lack of system of measuring and analyzing the quality of products and services	18
0.1819609	Lack of using originating control and inspection at production process	19
0.1707505	Lack of attention to strategies of entering into global markets	20
0.1679501	High waiting time at response to inquiries	21
0.1653574	Lack of culture of constant improvement of industries	22
0.1611613	Lack of adaptation of input technology with conditions ruling industry	23
0.1567114	Ruling of national vision instead of global vision	24
0.1559423	Lack of strategies for keeping valuable human resources	25
0.1536298	Lack of using unerring systems (Poka-Yoke)	26
0.1414841	Lack of skilled and specialized workforce	27
0.1412153	Lack of culture of criticism and paying attention to ideas	28
0.1405376	Low level of technical knowledge at products' manufacturing	29
0.1357372	High degree of wastage at the process of manufacturing	30
0.1353532	Lack of integrated information system of management	31
0.1120217	Lack of explicit definition of production's goal	32
0.1103315	Inattention to capital's arrival and foreign capitalist to industry	33
0.09343881	Lack of culture of group work	34

Third step

After being certain about accuracy of calculations, in order to prioritize alternatives that are in fact barriers of implementing e-factory system at industries, total weight of alternatives was calculated. LINGO software after combining all matrices, determining total weight based on LLSM. The same calculations were performed for all the alternatives associated with each criterion. Table (5) indicate priority of all alternatives.

RESULTS AND DISCUSSION

Results

For an AHP with complete information, the solution of LLS is equivalent to that of the geometric mean method. This of course gives a positive solution, because exponential values obtained by the inverse transformation of logarithm are always positive. Obtained weights shows that more than 60% of weights is devoted to the elements of management, organizational culture and human resources (Table 6); these elements are counted as critical and key elements at implementation of e-factory.

Table 6: Prioritizing barriers effective on implementation of e-factory system with AHP-LLSM method

Criteria	Weight
Management	0.2870762
Organizational Culture	0.1733387
human resources	0.1689245
production strategies	0.1218263
production technology	0.1185071
Just In Time Production	0.8324367E-01
Total Quality Management	0.4708346E-01

As it was predicted, the element of "Management" has the highest weight than other elements so this element has the most effect on implementation of e-factory system. The reality at interview with experts, conform to this result. Therefore regarding prioritizing identified barriers in relation with the elements of management, it should be tried for their solution that of course part of this duty is undertaken by organization and another part is undertaken by government and its macro policy-making.

Also regarding the result of ranking barriers of effective element at implementation of e-factory system, the degree of intensity of these barriers can be perceived that it is suggested to pay attention to this subject regarding obtained significance. After critical element of establishing e-factory system; that is (management, organizational culture and human resources) elements such as production strategy, technology, Just-In-Time production and total quality management are located. These elements are at the secondary importance and they can be named as productivity elements which are as a powerful competitive tool for company. Regarding that weight of these elements is almost close to each other they can be paid attention simultaneously. Here the only thing that should be considered is the severity and weakness of these elements that based on obtained weight their available barriers should be removed.

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