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ARTICLE

TECHNICAL AND ECONOMIC ASPECTS OF THE MANUFACTURING OF INDUSTRIAL STRUCTURES CASE STUDY WITH THE AIM OF IMPROVING AND UPGRADING THE PRODUCTION PROCESS

Mohammad Hosein Javadi[1]*, Mahmoud Heristchian[2], Mahdi Ravanshadnia[3]

Dept. of Engg. and Construction Management, Islamic Azad University, Science and Research Branch Tehran. IRAN

ABSTRACT

Due to the sensitivity of competition in the industry to offer a qualitative and consumer-oriented product as well as to access to a high-quality product with the lowest cost, the present research investigates the community needs and the encouragement of consumer to buy the product in terms of quantitative and qualitative aspects. Today, the use of and need for human resources for manufacturing lines require high costs, and result in low quality product. As a result, in this study we decided to provide strategies to improve the quality of product and to optimize the costs using mechanized production lines instead of human resources or the employment of minimum human force. Therefore, the objective of the present study was to investigate the factors influencing on manufacturing industrial structures (warehouse). The data were collected through the distribution of the researcher-made questionnaire (a questionnaire in 3 sections with 27 items) in 11 factories in 2015. The sample size was determined as 86 individuals according to Cochran formula. Analysis of the data by SPSS software indicates the effectiveness of all three factors of innovation, cost and time, and the quality in manufacturing of industrial structures. After the primary pre-processing, it was found that all three factors of innovation, cost and time, and the quality were effective in manufacturing industrial structures. According to results of Friedman test, we found that the factors of cost and time have the greatest impact on manufacturing of industrial structures and the quality factor has the minimal impact.

KEY WORDS
industrial structures (warehouse), innovation, cost and time, quality

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***Corresponding Author**
mhj1368@gmail.com

INTRODUCTION

Along with the progress of industry and technology, the needs for the various and single-purpose devices and equipments increase day by day. In addition to these variations, the various tastes of users and process of industry evolution have caused that the other old systems of production such as the difficult manufacturing line and automation are not responsible for permanent changes in market demands. As a result, by narrowing the competition field, in recent years the manufacturers have applied custom manufacturing systems, flexible manufacturing systems and soft automation to be able to satisfy of the needs of their customers and to guarantee their survival [1]. During the change and evolution of these manufacturing systems, computers have very important role in the conduct, control and follow the various manual or mechanical operations. On the other hand, to reduce human error and improve the level of reproducibility and accuracy, various robot have been designed and manufactured in order the manufactured products have higher quality and reliability [2].

Today, the use of and need for human resources for manufacturing lines require high costs, and result in low quality product [3]. As a result, in this study we decided to provide strategies to improve the quality of product and to optimize the costs using mechanized production lines instead of human resources or the employment of minimum human force.

Due to the sensitivity of competition in the industry to offer a qualitative and consumer-oriented product as well as to access to a high-quality product with the lowest cost, the present research investigates the community needs and the encouragement of consumer to buy the product in terms of quantitative and qualitative aspects [4].
In the context of the country's industrialization and forward movement of industries to achieve progress, paying attention to the needs of society and existing potentials, as well as the use of resources and materials available in Iran are of special importance.

According to the situation of Iran in terms of resources and materials available, as well as the growing industry of the country in recent years, the appropriate potentials exist for progress and competition with similar foreign industries.
In the present study, by investigating the role of quality in industrial products and doing interview and reviewing of previous studies about factories making metal skeleton, we try to identify the important factors in the designing and manufacturing industrial structures and then rank them using statistical methods.

MATERIALS AND METHODS

Since the researcher is going to use the results of the study in the short term and in the operation field (firm), therefore, the present study is an applied one in terms of its objective. It is also a survey in terms of its trajectory, in which the variables of the research are studied through a process comprising the decision-making steps on the subject, question or hypothesis or research, selection of the studied population and sample size, the determination of parameters and methods of data collection, and organization and analysis of data. Also,

this research is a case study in terms of data collection, which includes collecting data or new information from the subjects by methods such as observation, questionnaires, and interviews and so on. In the present study, the study population consists of 110 individuals (all experts working in the factories manufacturing metal skeleton in Iran). According to the variance obtained through pretest and the use of Cochran's formula ($n = \frac{N.Z^2_{\alpha/2}.S^2_X}{e^2.N-e^2+(Z^2_{\alpha/2}.S^2_X)}$), the sample size was estimated equal to 86 individuals. The subjects were selected through stratified cluster sampling method. To determine the validity of the measurement tool in this study, the content and face validity were used. In the present research like many other studies, to assess the reliability of the instrument, Cronbach's alpha was used [Table 1]. Cronbach's alpha coefficient is a number between zero and one. Alpha coefficients less than 0.6 indicate poor reliability. Alpha coefficients higher than 0.7 to 0.8 indicate relatively good reliability, and alpha coefficients higher than 0.8 indicate high reliability of measurement tool [5].

Table 1: Cronbach's alpha of variables

Variables	Alpha coefficient
Innovation	0.761
Cost and time	0.859
Quality	0.877
Total	0.901
Test result	Considering that the calculated Cronbach's alpha is higher than 0.70, it can be concluded that the null hypothesis is confirmed which means that the validity of the distributed questionnaire is good.

Collection of data

Data collection took place over several days and the researcher visited the studied firms and distributed the questionnaires and at the end of the day collected them, then the acceptable and valid questionnaires of each firm were categorized. The respondents were not forced to complete the forms and completion was carried out willingly and without any pressure in the allocated time. In the process, if it was observed that one participant completes the form haphazardly or with low accuracy, or in inappropriate conditions (in any form), that form would be deleted. In the process of distributing questionnaires and collecting data, accuracy and effort were applied and the activities such as the presence beside the respondent and frequent referent to him/her, as well as providing positive and useful explanations to demystify the probable ambiguities and increasing the respondent's tendency to complete the form and answer all questions correctly increased the accuracy and precision of the collected forms. However, in spite of all these actions, 90 questionnaires were distributed that very few of them were not returned and many more due to reasons such as incompleteness, failure to respond fully to the questions or flawed and invalid answers were not usable.

Solving method

In data analysis section, both descriptive statistics and inferential statistics (t-test and Friedman's test or symbols) must be used. In this study, data analysis is done in two parts, such that in the first part we study each of hypotheses which indicate the effectiveness of factor on the manufacturing of industrial structures. Then, using the confirmed hypotheses, each factor is ranked such that in the case of being parametrical the data, the t-test is used; otherwise, to show the variables to be important the sign test is used and to rank the variables Friedman's non-parametric test is used. Also, to study the normality of data, Shapiro-Wilk test is applied.

RESULTS

The first part of the questionnaire is related to demographic characteristics of respondents, including the education, fields of study, job title, experience and name of the factory where they work. Of 84 respondents, 10.7% had diploma, 14.3% associate diploma, 44% bachelors, 25% masters of art/science, and 6% had doctorate degree. Respondents were divided in five groups according to their fields of education majors, in a way that 54.8 percent of respondents were Civil engineering, 21.4% were Mechanic engineering, 2.4% were metallurgical and materials engineering, 6% had studied in Management course (all branches and sub-fields), and 15.4% had studied in other fields and majors.

To answer the hypothesis, the average scores related to questions (items) were used. Each item in the questionnaire was given a score between 1 and 5, so, according to statistical tests related to the hypotheses, the type of impact and its significance rate is determined by average scores; and finally if the error probability (P-value) is less than 0.05, it will mean that the hypothesis is confirmed, or statistically, we have:

The answer to research hypothesis is negative: $\mathbf{H_0}: \boldsymbol{\mu} = \mathbf{3}$

The answer to research hypothesis is positive: $\mathbf{H_1}: \boldsymbol{\mu} \neq \mathbf{3}$

To determine the type of test used, especially in the benchmarks (comparative tests), it is necessary to ensure the normality of variables [Table 2]. If the variables are normal, the use of parametric tests is recommended, and otherwise the non-parametric tests will be used.

Table 2: Results of Shapiro-Wilk Test in the studied variables

Factors	Shapiro-Wilk test	The significance level	Result
Innovation	0.908	0.206	Normal
Cost and time	0.971	0.053	Normal
Quality	0.972	0.064	Normal

The single-sample t-test is used to test the hypothesis about the population mean. In most of the studies that are done with Likert scale, this test is used to study the hypotheses and to analyze the technical questions related to them. Next, due to normality of variables, t-test was used to evaluate the presence or absence of the influence of the variables [Table 3].

Table 3. Results of student t-test

Variable	Degrees of freedom	student t-test	P-value
Innovation	83	20.320	0.000
Cost and time	83	28.106	0.000
Quality	83	13.369	0.000

According to the significant level of 0.05 and p-value, we conclude that the variables of innovation, cost and time, and quality are effective in the results; and according to being positive the result of t-test it is determined that the importance of innovation is very high.

Finally, in order to rank the results, Friedman test is used [Table 4].

Table 4: The results of Friedman test

Sample size	Chi-square statistic	Degrees of freedom	Significance level
84	50.425	**2**	0.000

According to the obtained significant level of 0.000, due to being lower than research significance level (0.05), it is clear that the effectiveness of the determined factors in the goal of study is not equal. Then, the effect of each factor is determined according to its rank such that a factor with lower rank has higher impact and vice versa (the factor with rank 1 has the highest impact) [Table 5].

Table 5. Ranking the factors effective in manufacturing industrial structures

Variable	Average ranking	Rank
Innovation	1.98	**2**
Cost and time	2.56	**1**
Quality	1.46	**3**

[Table 5] indicates that the variable of cost and time has the highest impact on manufacturing industrial structures, and the quality variable has the lowest impact.

CONCLUSION

According to what was said, the general objective of this study was to investigate the factors influencing the manufacturing industrial structures (warehouses). At first in order to make reader familiar with the issue, an introduction has been mentioned about the statement of the problem, and then the research methods and data collection methods were fully discussed. Finally, the results of data analysis were fully discussed and studied using SPSS software in both descriptive and inferential statistics.

In order to provide an answer to the main question of this study, some specific sub-questions were designed that by answering them the hypotheses of this study were tested and evaluated. In other words, based on the survey conducted, 11 factories were identified (Omran Sanat, Parag Sazeh, Sazvar Sazeh Azarestan, Roof Terrace, Folad Sanat Sazeh, Soliran, Kariran Soleh, Boniad Soleh, Omran Soleh, Rokn Soleh and Copal Company) that by using the ideas of line supervisors, experts of technical office, and experts of manufacturing line, the managers of manufacturing, the managers of the factories, etc. the questionnaire were completed. The results of this research were obtained by designing a questionnaire in three sections with 27 items. In this study, the effects of three factors of innovation, cost and time, and quality on manufacturing industrial structures (warehouses) were investigated. After primary pre-processing, it was found that all three factors, i.e., innovation, cost and time, and quality were effective on manufacturing industrial structures. Also, these factors were ranked in this study according to their effects. The main focus of this research was to provide useful strategies for the factories manufacturing industrial structures correctly by identifying the effective factors on this industry.

SUGGESTIONS

In this regard, the following researches are suggested to be carried out to develop concepts related to the manufacturing of the industrial structures (warehouses):

- Presentation of catalog for manufacturing industrial structures to provide the costumers' needs
- Product diversity in the systems of mechanized production
- Creating the culture of using industrial resources and saving the materials
- The use of rolled systems for constructing sections instead of welding and assembling
- Paying attention to human resources specialized in providing qualitative products
- Using shop maps in order to minimize the waste materials
- Paying attention to the repair and maintenance of automated production lines
- Providing periodic training courses to gain skills for welding and assembling segments and working with equipments
- The final control of assembled parts to prevent probable errors and mistakes
- The use of robots for assembling and manufacturing the parts
- Use of professional design and shop engineers
- Reduplication of the present study for similar products
- If future researchers repeat the present study in other geographical areas, not only more results will be achieved but also the generalization of results will be much more.

CONFLICT OF INTEREST
There is no conflict of interest.

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