Improving Product Quality Based on Supply Chain Effectiveness and T-JIT Production Implementation

Seyede Somaye Hosseini and Ehsan Korani

***Abstract*—Success at the supply chain level requires a supply chain management strategy and its ability to handle organizational management and as result of that has effect on product quality. The research results show that T-JIT[1] as a sustainable strategy, from supply chain management as a factor affecting product quality and supply chain capability as factors affecting product quality. Therefore, organizations that are willing to compete on the supply chain level are recommended to be among the JIT-productions, JIT-buyers, JIT-sellers and suppliers of JIT-information. In summary, production managers must take advantage of a T-JIT production strategy. The purpose of this study is to investigate the effect of T-JIT production system implementation and supply chain effectiveness on improving product quality. Statistical population of this research is 305 managers, supervisors and administrative staff of production industries. Data were collected using a questionnaire and analyzed with SPSS and AMOS software. Finally, it was observed that supply chain management strategy has a positive and significant effect on product quality, supply chain capability and T-JIT production. On the other hand, T-JIT production has a positive and significant effect on product quality and supply chain capability, and also the positive and significant effect of supply chain capability on product quality was confirmed.**

***Index Terms*—Product quality, supply chain capability, supply chain management strategy, T-JIT production.**

I. Introduction

The principle of Total Just in Time (T-JIT) is to eliminate sources of manufacturing waste by getting right quantity of raw material and processing the right quantity of products in the right place at the right time. T-JIT is a system that focuses on waste reduction and continuous improvement to achieve operational excellence. In a manufacturing context, T-JIT involves a manufacturing system where the parts needed to complete finished products are produced or delivered at the assembly site as required [1]. The goal of JIT practices is to reduce and eliminate waste [2]. Introduction of strict governmental regulations and the fast changing demand trends require the organizations to implement competitive strategies [3]. Due to these changes, the logistics market has been impacted by the increase of e-commerce and mass customization as well as the need for reduction time-to-market to maintain competitiveness. Just-in-time philosophy, mass customization, e-commerce, and Omni channel distributions influence the supply chain causing the need to automate logistics processes and to achieve an improvement in performance in a shorter period of time [4]. Just-in-time - JIT has been the name commonly used to describe a production system where necessary parts to complete finished products are produced or delivered at the assembly site as needed. The term JIT has gradually developed from a specific practice to be implemented on the factory and with suppliers to a philosophy of management that is aimed at continuous improvement in productivity through the continuous reduction of waste and reduction of inventories [5]. Using a T-JIT production system and mechanizing activities cause production costs and waste costs to reduced, product quality to increase and production capacity with maximum profitability to be optimally used. The two basic principles on which the T-JIT production system is built are: elimination of waste and full use of manpower.

T-JIT production succeeds only if every single person in the organization participates in it, plans and processes are designed to achieve maximum efficiency and effectiveness and the quality of products and production schedules are set in accordance with the request of customer.

By using this system, companies can produce and distribute products on time and sell their products at a competitive price at the lowest cost, without reducing quality. As a result, these companies can increase their market share and improve profitability [6].

II. Statement of the Problem

Today, quality management systems are very important in the management of companies and institutions. The goal of these systems is to increase the profitability and survival of the organization as well as customer satisfaction, along with a continuous reduction in real costs [7]. The production system is one of the most advanced planning systems, which is at the top of the pyramid of modern production planning and control systems. At present, in terms of economic constraints and the development and complexity of markets, the optimal use of available resources and T-JIT recognition and response to customer demands in different market segments have become inevitable and has led organizations to eliminate traditional structures and methods of working to maintain their market share [8]. When the term "T-JIT production" was first used in a management culture, it could have had different meanings for different people [9]. The T-JIT production system is an operational management approach in terms of reducing waste whose goals is to improve efficiency and quality, a technical management approach [10]. On the other hand, some have called it a strategic approach because the production system is a T-JIT

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[1] Total Just in Time

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production concept [11]. T-JIT production system as a sustainable supply chain strategy affects the overall ability of the supply chain and supports product quality.

In this study, according to Fig. 1, Green et al.'s research model on T-JIT production and its impact on supply chain management and product quality, it is sought to answer the question of whether T-JIT production can affect supply chain capability and the performance of companies.

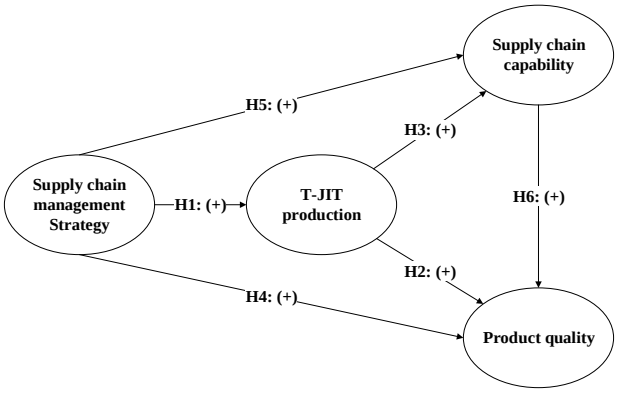

Fig. 1. Theorized model.

III. Hypotheses

Main hypotheses: T-JIT production has a positive and significant effect on supply chain capability and product quality.

Sub-hypotheses:

H1: Investigating the effect of supply chain management strategy on T-JIT production.

H2: Investigating the effect of T-JIT production on product quality.

H3: Investigating the effect of T-JIT production on supply chain capability.

H4: Investigating the effect of supply chain management strategy on product quality.

H5: Investigating the effect of supply chain management strategy on supply chain capability.

H6: Investigating the effect of supply chain capability on product quality.

IV. Statistical Population

The statistical population of this research consists of factory managers, operations managers and factory purchasing managers who have been targeted due to their special knowledge in the field of production, purchase, sale and information processes in their organizations. These factories operate in the petrochemical industry. The factory managers are 45 people, operations managers are 50 people, and purchasing managers are 210 people.

V. Research Methodology

Data analysis is a multi-step process. Through collection tools within the statistical sample (population), data that is collected, summarized, categorized, and finally processed to establish a variety of analyses and relationships between these data in order to test the hypotheses.

The first step in all statistical analyses is to examine the population distribution from which the sample is selected. In this section, before examining the hypotheses, the normality of the desired variables is examined. For this purpose, there use the non-parametric Kolmogorov-Smirnov test by (1), the result of which is shown in Table I.

H0: The data follow a specified distribution

H1: The data do not follow the specified distribution

$$D = \max_{1\le i\le N}\left(F(Y_i) - \frac{i-1}{N}\ ,\ \frac{i}{N} - F(Y_i)\right) \quad (1)$$

TABLE I: Normalization of the Distribution of Research Variables through Kolmogorov-Smirnov

Variable	Test statistic	P-value
Supply chain management strategy	0.181	0.001
T-JIT production	0.159	0.001
Product quality	0.094	0.000
Supply chain capability	0.173	0.002

According to the significant levels obtained from data analysis, it is observed that none of the research components follow the specified distribution, because their value is less than significance level 0.05. Therefore, the null hypothesis of the test is rejected and the distribution of any of the research variables is not normal. Therefore, Spearman correlation coefficient should be used to examine the relationship between variables.

VI. Testing the Hypotheses

According to the results obtained in the previous section and the abnormality of the data distribution, at this paper use Spearman correlation coefficient to examine the relationships between variables. Equation (2) is Spearman correlation coefficient. Its size shows the degree of relationship between these two variables and its direction (positive and negative) shows the consistent behavior and inverse of the two variables. In this section, the research hypotheses are analyzed.

$$\rho = 1 - \frac{6\sum {d_i}^2}{n(n^2-1)} \quad (2)$$

where

ρ: Spearman`s rank correlation coefficient

di: difference between the two ranks of each observation

n: number of observations

The hypothesis of this test is such that:

$H0$: They are not correlated

$H1$: They are correlated

TABLE II: Investigation of Spearman Correlation Coefficient between Variables

Variable	Spearman correlation coefficient	P-value
Supply chain management strategy to T-JIT production	0.408	0.000
T-JIT production to product quality	0.450	0.002
T-JIT production to supply chain capability	0.623	0.001
Supply chain management to product quality	0.514	0.001
Supply chain management to supply chain capability	0.703	0.000
Ability of supply chain to product quality	0.549	0.002

Therefore, if its significance level is less than 0.05, it will reject the *H*0 hypothesis, thus confirming the correlation for the variables. The results of the Spearman correlation coefficient between the variables are shown in Table II.

VII. Structural Equation Model of Research

To better investigate the relationships between research variables, structural equations are used. The most important reasons for researchers' overuse of structural equations are the ability to test theories in the form of equations between variables. You can see the structural equation modeling of this research using AMOS software in Fig. 2.

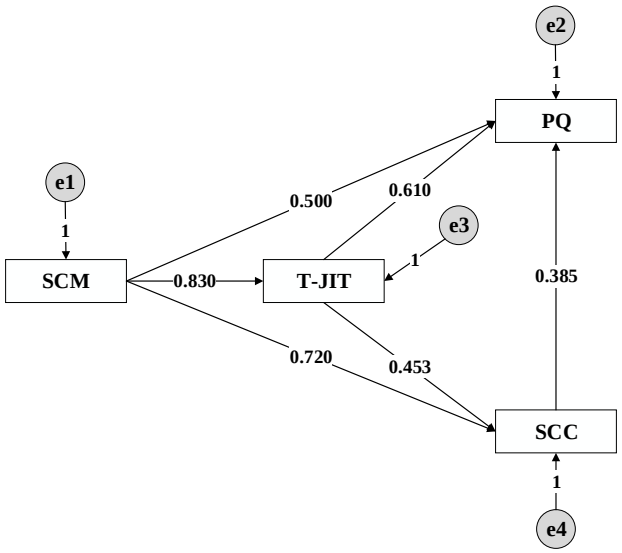

Fig. 2. Structural equation model of research.

The results of this study are shown in Table III.

According to the Table III, it can be seen that all of the coefficients are positive and since the level of significance obtained for all relationships is less than 0.05, it can be concluded that the relationship between the variables is positive and significant.

In order to evaluate the appropriateness of the model, the fit indices given in Table IV are used.

As it can be seen, the values obtained indicate the appropriateness of the model and the fit indices are all at the desired level, so there is no need to modify the model.

Also, the value of chi-square distribution is calculated for the model introduced above according to (3) and is shown in Table V.

$$f(x) = \begin{cases} \frac{x^{k/2-1}\, e^{-x/2}}{2^{k/2}\, \Gamma(k/2)} & for\ x \geq 0 \\ 0 & otherwise \end{cases} \quad (3)$$

where:

$f(x)$: probability density function

k: degrees of freedom

$\Gamma(k/2)$: gamma function

In the table above, the chi-square value is 14.517. Likewise, the level of significance is zero. Because the level of significance is less than 0.05, the appropriateness of the model is accepted.

VIII. Discussion

According to the statistical tests performed on the research data, the results are presented separately for each hypothesis below.

Hypothesis 1: According to the results obtained from the analysis of the data of the first hypothesis, the value of the correlation coefficient is 0.408 and the significance level is 0.000. Since the value of the correlation coefficient is positive, it indicates a positive and strong relationship between the two variables of supply chain management and T-JIT production strategy. The structural equation model, with a coefficient of 0.83 at the significant level of 0.000, shows that there is a positive and significant relationship between these two variables. This means that by changing one unit in the supply chain management variable, the T-JIT production strategy increases by 83%. Therefore, the above research hypothesis is accepted.

TABLE III: Coefficients Observed in the Structural Equation Modeling

Impacts	Estimation of Coefficient	P-value	Level of Error
The Impact of Supply Chain Management Strategy on T-JIT Production	0.830	0.000	0.114
The Impact of T-JIT Production on Product quality	0.610	0.000	0.205
The Impact of T-JIT Production on Supply Chain Capability	0.453	0.000	0.241
The Impact of Supply Chain Management Strategy on Product quality	0.500	0.000	0.146
The Impact of Supply Cha Management Strategy on Supply Cha Capability	0.720	0.004	0.250
The Impact of Supply Chain Capability on Product quality	0.385	0.002	0.094

TABLE IV: Fit Indices of the Model

Index	Desired limit	Reported value
Root Mean Square Error of Approximation (RMSEA)	0.08 and lower	0.054
Normed Fit Index (NFI)	0.9 and upper	0.99
Non-normed Fit Index (NNFI)	0.9 and upper	0.98
Comparative Fit Index (CFI)	0.9 and upper	0.99
Incremental Fit Index (IFI)	0.9 and upper	0.99
Root Mean Square Residual (RMSR	Near to Zero	0.011
Goodness of Fit Index (GFI)	0.9 and upper	0.99

TABLE V: Chi-Square Value

Chi-Square Value of CMIN/DF	P-value
14.517	0.000

Hypothesis 2: According to the results obtained from the analysis of the data of the second hypothesis, the value of the correlation coefficient is 0.450 and the significant level is 0.002. Since the value of correlation coefficient is positive, it indicates a positive and strong relationship between the two variables of T-JIT production strategy and product quality. The structural equation model, with a coefficient of 0.61 at a significant level of 0.000, shows that there is a positive and significant relationship between these two variables. This

means that by changing one unit in the T-JIT production strategy variable, product quality increases by 61%. Therefore, the above research hypothesis is accepted. The results are consistent with the research of Inman [12] who showed that T-JIT production strategy has a positive and significant effect on product quality.

Hypothesis 3: The value of correlation coefficient is 0.623 and the level of significance is 0.001. Since the value of the correlation coefficient is positive, it indicates a positive and strong relationship between the two variables of T-JIT production strategy and supply chain capability. The structural equation model, with a coefficient of 0.453 at the significant level of 0.000, shows that there is a positive and significant relationship between these two variables. This means that by changing a unit in the T-JIT production strategy variable, the ability of the chain supply increases by 45%. Therefore, the above research hypothesis is accepted. The results obtained with the research of Torkabadi [13] which showed that the T-JIT production strategy has a positive and significant effect on the ability of the supply chain.

Hypothesis 4: The value of correlation coefficient is 0.514 and the level of significance is 0.001. Since the value of the correlation coefficient is positive, it indicates a positive and strong relationship between the two variables of financial performance and social responsibility. The structural equation model, with a coefficient of 0.50 at the significant level of 0.000, shows that there is a positive and significant relationship between these two variables. This means that by changing one unit in the supply chain management strategy variable, product quality increases by 50%. Therefore, the above research hypothesis is accepted. The results are consistent with Petrovik [14] who showed that supply chain management strategy has a positive and significant effect on product quality.

Hypothesis 5: The value of correlation coefficient is 0.703 and the significance level is 0.000. Since the value of correlation coefficient is positive, it indicates a positive and strong relationship between the two variables of supply chain management strategy and supply chain capability. The structural equation model, with a coefficient of 0.72 at the significant level of 0.004, shows that there is a positive and significant relationship between these two variables. This means that by changing a unit in the supply chain management strategy variable, supply chain capability increases by 72%. Therefore, the above research hypothesis is accepted. The results are consistent with Green [15] who showed that supply chain management strategy has a positive and significant effect on supply chain capability.

Hypothesis 6: The value of correlation coefficient is 0.549 and the level of significance is 0.002. Since the value of correlation coefficient is positive, it indicates a positive and strong relationship between the two variables of supply chain capability and product quality. The structural equation model, with a coefficient of 0.385 at the significant level of 0.002, shows that there is a positive and significant relationship between these two variables. This means that by changing a unit in the supply chain capability variable, product quality increases by 39%. Therefore, the above research hypothesis is accepted. The results are consistent with the research of Green et al. who showed that supply chain capability has a positive and significant effect on product quality.

IX. Conclusion

At this paper found that success at the supply chain level requires supply chain management strategy and competency as well as organizational management. Our results support T-JIT as a viable supply chain management strategy. In short, manufacturing managers should benefit from adopting a T-JIT strategy. This comprehensive strategy will serve to move the supply chain toward the ultimate goal of delivering zero-defect, quality products to the supply chain's ultimate customers in the exact quantities and at the precise times desired by those customers. The overall result is summarized in Table VI.

TABLE VI: Summarize of Conclusion

Hypotheses	Statistical result	Result of hypothesis
H1: Supply chain management strategy has a positive and significant effect on T-JIT production	Reject of H_0	correlated
H2: T-JIT production has a positive and significant effect on product quality	Reject of H_0	correlated
H3: T-JIT production has a positive and significant effect on the ability of the supply chain	Reject of H_0	correlated
H4: supply chain management strategy has a positive and significant effect on product quality	Reject of H_0	correlated
H5: supply chain management strategy has a positive and significant effect on supply chain capability	Reject of H_0	correlated
H6: Supply chain capability has a positive and significant effect on product quality	Reject of H_0	correlated

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Seyede Somaye Hosseini designed and directed the project. Also, Seyede Somaye Hosseini conceived of the presented idea, drafted the manuscript, and designed the figures. Ehsan Korani collected the data, developed the theory, and performed the computations.

Seyede Somaye Hosseini verified the analytic calculations. Seyede Somaye Hosseini supervised the findings of this work. All authors discussed the results and contributed to the final manuscript and approved the final version.

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