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Analysis of necessary developments in the automotive industry in a world-class system

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Article	Abstract
<p>Article history: Received: 20th May 2021 Received in revised form” 10th June 2021 Accepted: 15th June 2021</p> <p>Keywords: world-class manufacturing; DEMATEL; importance- performance analysis; essential points for improvement</p>	<p>The purpose of this paper is to examine and identify gaps in the manufacturing system of world-class (WCM), In the auto industry and to set the necessary improvements to the systems in the organization using the importance-performance analysis (IPA). This paper provides a mix of the theoretical and practical framework outlined in the literature review and integrates the experts' views. The main characteristics of the world-class production system in Saipa Company were identified. Using the importance-performance analysis (IPA), the essential points for improving the company's world-class production system were determined and discussed. The gap analysis results and determination of areas of improvement were obtained using Performance Analysis (Importance performance analysis). Using this model system in world-class manufacturing in Saipa company help the supreme managers and supervisors to identify areas that need improvement in the company, and after improvement measures in these areas, ensure the success of this system for the establishment and being able to make the right decisions in the area of world-class production in this way. This paper is undoubtedly one of the most important methods for determining and analysing the improvements of the organizations and the establishment and implementation of WCM. Many solutions will be provided for the specialists.</p>

1- Introduction

A world-class production is an essential tool for meeting some of the significant challenges and barriers to entry and survival in the global economy and the growth of their potential forces. Today, one of the things that have occupied our country's top decision-makers minds essentially is the debate on globalization. The need for globalization, especially in the production sector, is

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increasingly felt [1]. The importance of global competition has intensified various issues at the organization's micro and macro levels. Meanwhile, although many Iranian organizations do not yet have the conditions for competition, given the future trends, their presence in the international competition arena is not far from expected. Therefore, it is vital to study and study issues in the dimensions of global competition. World-class production is a topic that is heard a lot today in competition and international trade. Even Iranian organizations have particular importance in the theoretical and executive field [2, 3]. The significance of the present issue is its success and increasing Saipa Company's competitiveness compared to its other competitors.

One of the most critical production sectors in which many investments have been made in the automotive industry. Automobile manufacturing is an essential and integral component of global trade and industry. Surveys show that more than 58 million people (directly and indirectly) are employed in the global automotive industry (more than 5% industrial employment). The turnover of this industry is over 1.1 trillion dollars. Also, more than 66 million vehicles in 2005 represent the most significant activities and factors related to automobile manufacturing [4]. Peter Drucker refers to this industry as "industrial industry". In Iran, over 5000 billion tomans have been invested in car manufacturing companies and more than 200 parts manufacturing companies [5].

Saipa has developed its scientific and research capabilities to achieve world-class as a brand-owned car and has reached the latest technologies in cooperation with reputable European companies. Global competition, rapid technology changes and short life cycles created the current highly competitive environment in the manufacturing industry. Companies have been forced to evaluate their plans due to a new competitive climate, continuously changing manufacturing and business standards [1]. The present study aims to analyze the gap and determine the necessary points for improving the world-class production system. In this research, we find the influential factors in evaluating Saipa Company's world-class production and identifying the essential issues for improving Saipa Babol Company's world-class output. At the same time, this study investigates gaps in the world-class production system (WCM) in the automotive industry. It determines the necessary points for improving this system in the organization using significance-performance analysis (IPA). This article analyses the most critical indicators in the world-class production system and establishes this system in Saipa Company. The gaps and necessary points for improvement are analyzed.

2- Theoretical foundations and research background

2-1-World class production

First coined by Hayes and Wilright in 1984, World-class production had appeared in several formulas as an extract from the ideas of Japanese production in the 1970s when Western production failed. And the inability to compete was perceived. In the 1980s and 1990s, world-class production was formulated and marketed as a revolutionary business technique in the United States and the United Kingdom [6]. They were able to evaluate and compare the various approaches. World-class manufacturers, according to German, American, and Japanese corporations, must develop in six areas to have a competitive edge, including worker skills and abilities, technical, managerial capabilities, and quality (as Competitive weapons), employee participation, restructuring in construction engineering, and an attitude of increasing improvement. The concept of world-class production was then expanded, embraced, and augmented by several authors, who reinforced some of Hayes' and Willerite ideas [9]. With his valuable work, World-Class Production, Richard Schoenberger has contributed to the development of this concept in the operational literature [4]. Throughout the late 1980s and 1990s, Schnberger (1986) [7] formed the World Class International Consulting Company (WCI), which operated in Europe and the United Kingdom. GlaxoSmithKline, Clarks Shoes, Cotts Villa, and Midland Bank are among the British clients. In the late 1990s, the WCI's interpretation of WCM declared that a world-class firm was organized to serve the client, but it needed to return to basics. This entails a constant and quick improvement in customer service through higher quality, lower and faster prices, and increased flexibility and responsiveness. They highlighted the integration of WCM approaches.

2-2-World-class production definitions

Unfortunately, there is no precise, accepted, and universal definition of world-class production [4]. Sharma (2005) [8] states that you are among the best in the world in your profession if you are world-class. World-class production is becoming the best globally in a particular industry sector. Schnberger (1986) [7] describes world-class production as methods for the slogans of the Olympic Games cities, *Altius* and *fortius* that are faster, more powerful.

Table 1 Summarizes the research conducted in the world-class production model

No.	Authors	Year	Summary of findings
1	Riad Eid	2009	Model in General The concept comprises two kinds of enablers that contribute to WCM implementation success: WCM technical enablers and WCM strategic enablers used to create world-class manufacturing [9].
2	Sangwan and Digalwar	2008	Management commitment, knowledge management, technology and innovation, flexibility, quality, production control and planning, vendor management, customer happiness and service, staff strengthening and training are essential variables to consider when assessing WCM systems. Environmental safety and health, cost, and corporate development are all factors to consider [10].
3	Farsijani	1390	With three phases in each phase, the organizational characteristics development model supports Iranian organizations' progression to become world-class producers. Each phase evaluates a set of fundamental qualities of world-class organizations and attempts to establish them in Traditional organizations [11].

2-3 Significance-Performance (IPA) Technique

Significance-Performance Analysis (IPA) derived from Importance-Performance Analysis is one of the methods of gap analysis. This technique was first introduced in 1977 by John Martila and John James. In terms of data gathering, this strategy is highly similar to the SERVQUAL methodology. The Significance-Performance Analysis is a valuable method for evaluating a company's competitive position, identifying areas for development, creating marketing plans, and offering focused service. Marita and James offered a significance-performance analysis for the first time, allowing a business to discover and prioritize product or service aspects that it may focus on to enhance customer happiness. Practical advice may be presented to managers by creating a two-dimensional matrix with a vertical axis that reflects consumers' perceptions of each feature's performance (quality) and a horizontal axis that illustrates the relevance in consumer decision-making. The importance-performance matrix is a two-dimensional matrix.

Data on the level of significance and performance of the indicators on two-dimensional networks where the y-axis indicates the significance dimension and the X-axis indicates the performance dimension, because separate analysis of performance and significance dimension data, mainly when each data set is studied simultaneously, may not be meaningful (Figure 1). The significance/performance matrix, often known as the IP matrix, is a two-dimensional network. The IP matrix's job is to aid decision-making. It is divided into four portions or quarters, with each

strategy having its system in each quarter. This matrix is used to determine which indications should be prioritized for improvement [12].

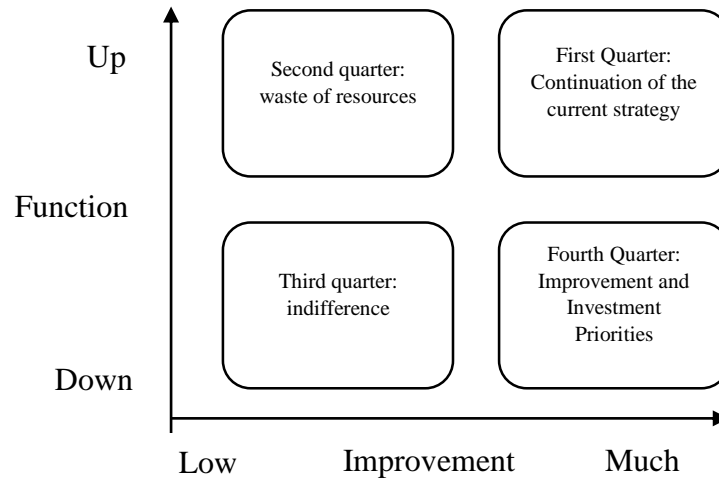


Figure 1 Matrix IPA

Based on how important each indicator is (optimal status) and how well the organization performs in this area (current situation), four quarters can be identified:

Scope of indifference: low performance-low importance

Waste range: high performance - low cost

Weaknesses: Low Performance-High importance

- Acceptable scope: high performance - high importance

The second and fourth quarters have a substantial gap in the significance-performance analysis model. If most of the indicators are in the second quarter, the firm has invested in low-value indicators. In the realm of unimportant indicators, the performance is excellent. If most of the indicators are in the fourth quarter, the organization's substantial important indicators are doing poorly. The fourth quarter's elements should be transferred to the first quarter, and all features from the second and third quarters should be removed.

SERVQUAL and competitive analysis benefit significantly from the significance-performance research. The paired t-test, like other gap analysis methods, may be used to accomplish this study. Data is usually collected using a questionnaire with a range of 5, 7, or 9 questions. For each indication,

there are two sorts of questions. A question that assesses the current situation and a question that sets the desired position.

According to the above information, the step-by-step method of significance-performance analysis is as follows.

Step one:

First, identify and extract the quality characteristics that play a role in the quality of services.

Step two:

Specify the degree of importance of service quality characteristics and the quality characteristic's degree of performance ($P = 1, 2, \dots, n$ and $J = 1, 2, \dots, m$). Value donors are values and performance values specified for the j attribute by the decision-maker or the client. These values are determined using the Likert spectrum. In this case, it is clear that $1 \leq b_{jp}, c_{jp} \leq 5$ or $1 \leq b_{jp}, c_{jp} \leq 7$.

Step three:

Use the geometric mean and integrate the opinions of all decision-makers or customers. Saati suggests that using the geometric mean to express several decision makers' collective opinion is a more effective solution. Quality of service is called the result of the collective view of the customer or expert.

$$c_j = \left(\prod_{i=t}^n c_{jp} \right)^{\frac{1}{n}}, \quad b_j = \left(\prod_{i=t}^n b_{jp} \right)^{\frac{1}{n}}$$

Thus, each qualitative characteristic (j_m) has a degree of importance and a degree of performance.

Step 4:

Calculate the threshold value. The threshold value is used to determine the IPA matrix cells. An arithmetic mean is used to determine the threshold value. The significance threshold value and the performance threshold value are denoted by μ_b and μ_c , respectively.

$$\mu_b = \frac{\sum_{j=1}^m b_j}{m}, \quad \mu_c = \frac{\sum_{j=1}^m c_j}{m}$$

M is the number of quality characteristics to measure the quality of services.

Step 5:

Specify the relative position of each service quality characteristic on the IPA matrix.

Note that μ_b and μ_c will not necessarily be in the middle.

Step 6:

Discovering the customer's voice helps to gain the weight of the customer's wishes. According to Wu et al., The gap between the value of significance and the performance of the j-characteristic multiplied by the value of its importance can indicate the weight of the qualitative characteristic of the j-th. We denote the weight of the j-characteristic by ow_j .

$$ow_j = |(b_j - c_j) * b_j|$$

To make the analysis more accessible, we normalize it as follows.

$$sw_j = \frac{ow_j}{\sum_{j=1}^m ow_j}, 0 \leq sw_j \leq 1, \sum_{j=1}^m sw_j = 1$$

Now features that have more sw_j should be given higher priority for improvement.

3- Research model

Sanguan and DeGalvar (2008) [13] provided 12 important variables for evaluating world-class systems in research, as previously noted. Top-level commitment (TM), knowledge management (KM), technology, and innovation are among the 12 critical components. (IT), Customer Satisfaction (CS), Flexibility (FX), Quality (QC), Production Control and Planning (PPC), Vendor Management (VM), and Service (CSS), Employee Empowerment and Training (ETE), Environmental Safety and Health (EHS), Cost (CST), and Corporate Growth (CG) are the critical factor models for evaluating the world-class production systems presented by Sanguan and Digalvar as shown in Figure 2 and Table 2:

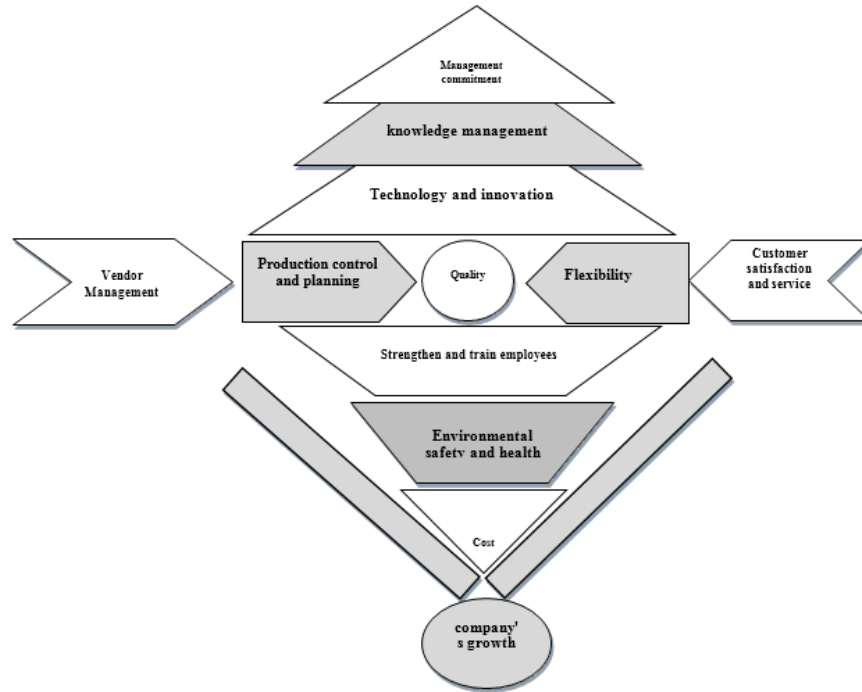


Figure 2. Sanguan and Digalvar models (2008)

Table 2 Sub-criteria of the research model

No.	Critical factor	Performance variable
1	Top management commitment	Resource allocation, change management, process monitoring, and strategic quality management involvement
2	knowledge management	Knowledge management resources are available. - Knowledge management organizational culture that is appropriate - Employees' readiness to share knowledge, information, communication, and technology (ICT) in the context of knowledge management- A large number of knowledge pieces aided in the solution of difficulties. - Assist with knowledge management to save time Delay / Response, Reduction in process turnover rejection - Knowledge management reduces the time it takes to produce a new product. - Presentations, conferences, negotiations, and other activities that contribute to the creation of new knowledge.
3	Strengthen and train employees	Training and retraining repetition (continuity) - In-house training with an in-house trainer (including on-the-job training) - In-house training with an out-of-company teacher - Total training cost - Identification of training needs - Employee satisfied with overall training - Authorized workers reviewing their work - Workers encouraged to address problems - The number of task force members.
4	Innovation technology	Manufacturing process improvement - Manufacturing delay reduction - Development of new (innovative) items - Production of items that only operate in their native environment

5	Environmental safety and health	Putting money into safety (safety training budget) - Levels of communication in the fields of security and health - Discipline procedures that are clear - Organization for safety (control, communication, cooperation and competition) - Auditing for safety and health - Meetings of the committee Employee safety - Participation of the workforce and senior management in health and safety - Assessment of employees' awareness of health and safety regulations
6	Vendor Management	Implementation of a supplier rating system - Expansion of long-term contracts with suppliers - Clarity of supplier requirements - Supplier responsiveness to change requests - Communication with suppliers Selection of suppliers based on quality rather than price or schedule
7	Planning and production control	Efficient/preventive maintenance rate - Production schedule stability - Process automation degree - Number of Kaizens completed
8	Quality	System development and quality policies - Reliability, reliability and functionality of the product related to competitors - Estimated percentage of satisfied customers - Quality stability - Effectiveness of the system in identifying defective products.
9	Flexibility	Fluctuations that occur in quality with changes in volume or composition of the product - Fluctuations that occur in cost with changes in volume or design of the product - Fluctuations that occur in delivery performance with changes in volume or composition of the product - The use of electronic procurement - Use of IT tools - The use of multi-purpose tools.
10	Cost	Costs associated with material handling, distribution, and warehousing - Costs related to after-sales service (warranty) - Costs of information upkeep are reduced. - The expense of facility upkeep (equipment failure or failure cost, cost of Equipment failure, cost of repairs and rework, cost of spare parts inventor).
11	Customer satisfaction and service	Customers that have interacted with you / prospective customers - consumer comments on quality, delivery, and pricing - satisfying consumer demands - consumer satisfaction with the product (features, quality, pricing, durability, and dependability) - consumer-suggested sales (auction) - the process of quality assurance and customer service - Customer service knowledge, abilities, and attitudes - Time to pass (transfer) problems to workers who can best address them - Using ICT to provide customer service - The consumer receives technical assistance.
12	company's growth	Profitability - Increasing market share - Organizational reputation in the market - Increasing the number of customers.

According to the current research model, how to determine the necessary points for improving Saipa Babol Company's world-class production?

This question will be answered in the following sections.

4- Methodology

Analysis of research data and findings

Localization of indicators

Identify and evaluate effective criteria

To identify the effective criteria in world-class production, Sanguan and Digalvar (2008) [13] article have been used, and the extracted criteria have been fully mentioned. Because the number of identified criteria is high, the Delphi hourly method has been used to localise criteria and determine the current research's essential criteria. A questionnaire has been provided to the experts.

This questionnaire is qualitatively based on a 10-point spectrum from completely unimportant to completely important. After collecting and screening, and determining the critical criteria and characteristics, the Delphi technique performs calculations with software help. EXCEL is done.

After calculations and data output from EXCEL software, the indicators that after aggregation of experts' views and arithmetic mean were slightly higher than the threshold value of 0.7 were confirmed.

Experts re-examined the results of screening and determining the degree of importance of the indicators. Finally, 12 indicators were identified as the leading indicators and were selected as the main criteria for the model's final solution. Table 3 is the leading indicators of world-class production.

Table 3 Importance of critical indicators

Critical factor	Importance of key indicators	Critical factor	Importance of key indicators
Top management commitment	0.72	Flexibility	0.87
Knowledge management	0.72	Customer satisfaction and service	0.82
Innovation technology	0.94	Strengthen and train employees	0.81
Vendor Management	0.74	Environmental safety and health	0.742
Planning and production control	0.77	Cost	0.75
Quality	0.98	Company's growth	0.94

Table 4 Importance of sub-indicators

Sub-index	Score	Sub-index	Score	Sub-index	Score
Process monitoring	0.728	Participation in management	0.714	Stability in quality	0.825
Retraining	0.714	Reduce product development	0.771	Respond to customer needs	0.814
The total cost of training	0.714	Educational needs	0.728	Delivery and price-performance	0.728
Satisfaction with education	0.642	Workers' authority to review	0.814	Profitability	0.871
Encourage workers	0.757	Teamwork	0.7	Organizational reputation in the market	0.942
Development in the manufacturing process	0.914	Reduce latency	0.714	Resource allocation	0.8
Policies of order	0.728	Safety and health audit	0.728	Increase market share	0.9
Labor force participation	0.714	Select suppliers	0.8	Increase the number of customers	0.914
Supplier completion	0.714	Communication with the supplier	0.712	System effectiveness	0.8
Supplier response	0.7	Production program stability	0.775	Feedback on quality	0.7
Quality policies	0.7	Reliability, reliability	0.737		
Percentage of satisfied customers	0.757	Time to send customer problems	0.728		

Table 3 is about the importance of the leading indicators that the experts scored, and because all the central hands were above the threshold of 0.7, all of them have been accepted. Table 4 deals with the importance of sub-indicators that experts scored, and because all major indicators were above the threshold of 0.7, all of them have been accepted. A total of 34 factors with a score higher than 0.7 were selected.

Gap analysis and determination of essential points for improvement

According to the methods and steps of the significance-performance model method to determine the improvement points in this method, after aggregating the opinions and obtaining the final IPA table threshold, each factor is drawn according to the characteristics determination table. According to the drawing and placement of each element in one of the four quadrants of the chart, the points located in the second and fourth quarters of this chart are improvement points. In the same way that the issues are in the second quarter, the organization should increase its focus. In contrast, the factors that are in the fourth quarter of the chart are the factors that waste the organization's resources, so the organization should focus on this. Reduce the points that characterize each element.

In this study, according to the nature of the subject and its techniques, a questionnaire was used to collect data by field survey and experts' survey.

Research conducted in scientific articles, similar studies, and interviews with experts identified in previous stages has been used to determine the practical characteristics of world-class production.

A step-by-step method for IPA

First, we identify and extract the quality characteristics that play a role in the quality of services according to the essential and effective criteria shown in Table 3. To 7 experts, a questionnaire containing each of these factors' importance and performance were given. Experts' opinions were asked about the organisation's critical instead of how these factors are implemented in the organization. Experts rated these factors on a scale of 1 to 5 (very low to very high).

After summarizing the opinions and determining the experts' main factors' characteristics, the threshold for the sum of these factors was selected, which is indicated by the Latin word and abbreviation.

Table 5 aggregation of expert opinions

Critical factor	Importance of key indicators	Performance	Critical factor	Importance of key indicators	Performance
Top management commitment	2.9	2.78	Flexibility	4.36	1.57
Knowledge management	2.9	3.02	Customer satisfaction and service	4.05	2.37
Innovation technology	4.36	1.57	Strengthen and train employees	3.07	3.55
Vendor Management	2.37	3.82	Environmental safety and health	2.03	3.44
Planning and production control	3.2	3.2	Cost	3.2	2.03
Quality	4.09	1.91	Company's growth	4.54	1.51

After collecting opinions from experts, a geometric mean was taken. The results of each were given in Table 5 to determine the significance-performance diagram's characteristics. In the next step, the threshold was obtained for each of the attributes of importance and performance, which sets the point of importance μ_b and the version with μ_c , shown in below.

Set the threshold

$$\mu_b = b_j / m$$

$$\mu_c = c_j / m$$

$$\frac{\mu_b}{\mu_c} = \frac{3.425483}{2.569181}$$

Now, concerning the above tables, the position graph is plotted to determine the production deployment gap in the world-class, with μ on the horizontal axis (Y) and μ on the vertical axis (X). The intersection of two points is the status of each organisation's essential characteristics in the current situation.

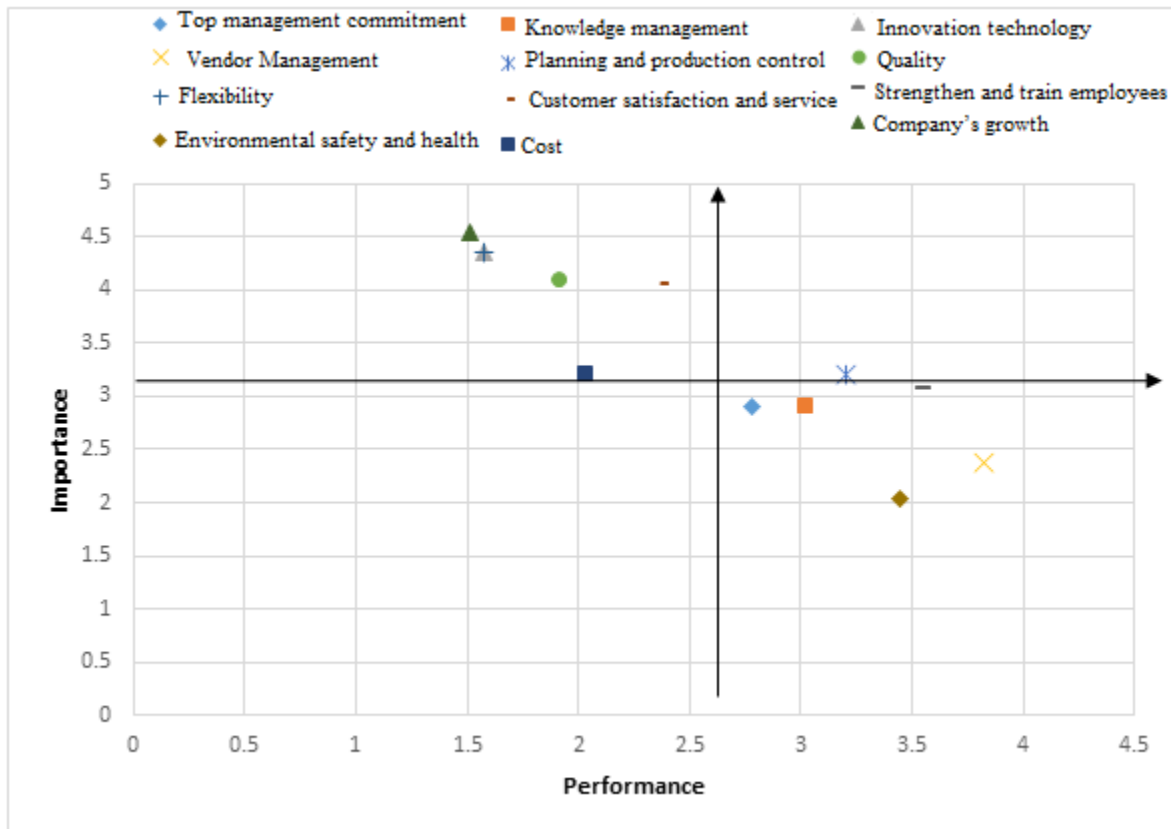


Figure 3 relates to graph drawing in a performance-analysis model

5- Discussion and conclusion

Given that the core gap is in the model of significance-performance analysis under the second quarter and Jaharm, now the features in the fourth quarter, implying that the organization has concentrated and invested on indicators that are not worth much. High performance in the realm of trivial indicators) and waste of resources. However, indicators that are of high importance and are in the second quarter have poor performance of the company or organization about these factors. According to the graph, the second quarter (focus) factors (focus) and the fourth quarter (waste of resources) are the points of improvement. This means that the organization must pay attention to

these factors in these two positions to improve. The points that the organization should pay more attention to or focus on and the points that the organization should focus less on because they are wasting organizational resources are listed in Table 6. respectively.

Table 6 points of improvement in the significance-performance analysis model

The second category (waste of resources)	The first category (focus)
Vendor Management	company's growth
Safety and health	Flexibility
Knowledge management	Technology and innovation
Management commitment	Quality
	Customer satisfaction and service

According to the indicators mentioned in Table 6, the importance of improving each of the indicators in the importance-performance analysis model has been determined according to the OWJ and FWJ formulas, which are categorized and prioritized, respectively.

Table 7 The importance of improving the characteristic at the gap point

Company's growth	Safety and health	Customer satisfaction and service	Flexibility	Quality	Vendor Management	Technology and innovation	knowledge management	Management commitment
13.78	2.87	6.78	12.15	8.88	3.44	12.15	0.35	0.33

However, the characteristics that have more SWJ should be given higher priority for improvement. Factors: 1- Company growth 2- Technology and innovation, 3- Flexibility 4- Quality 5- Satisfaction and service and customer 6- Seller management 7 Safety and health 8. Knowledge management 9. Management commitment was ranked in the priority of improvement.

According to Riyad Eid (2009) [14], manufacturing plants must understand "factors influencing the successful implementation of production in the world in developing countries, the case study of Egypt" in an article titled "Factors influencing the successful implementation of production in the world in developing countries, the case study of Egypt." Seven critical criteria are categorized into two groups that play a significant role in applying and implementing wcm approaches. 1- Management commitment is the first category. 2- Quality Assurance Department, The second group, includes 1- Supply chain, 3- Continuous Improvement, and 4- Customer Participation. 2- Technical capability management 3- Production facility management, according to the present research, the criteria are centred on the friend. The waste of resources is divided, which is entirely similar to the first category of Riyad Eid in terms of content. The factors of management commitment, quality,

satisfaction and customer service are considered identical to the Riyad Eid model. However, the method of obtaining these factors has been different. Digalwar et al. (2015) [15], in their latest article in 2015 on performance and implementation of wcm in the organization, have started performance modelling and have written an article entitled "Modeling production performance in the world-class". In this paper, 16 main criteria and 172 sub-criteria have been introduced, similar to the previous model used in the current study. However, in this article, Sanguan et al. Using the ISM method, essential factors and Important are the commitment of senior management, knowledge management, staff training, innovation and technology, which are placed above other factors as important factors, which is similar to the current research, with the difference that these factors in the current research as gaps and Improvement points were identified and the IPA method was used to achieve this.

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