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Original Research Article

Identifying & Ranking the Key Factors Affecting the Quality Assurance (QA) of High-Tech Products in Turbine Engineering and Manufacturing Companies

Abbas Khamseh*[1], Maryam Kheradranjbar[2] and Ali Khamseh[3]

1. Department of Industrial Management, Karaj Branch, Islamic Azad University, Karaj, Iran

2. Department of Technology Management, Science & Research Branch, Islamic Azad University, Tehran, Iran

3. Department of Industrial Engineering, Karaj Branch, Islamic Azad University, Karaj, Iran

*** abbas.khamseh@kiau.ac.ir**

Abstract

Due to the unique features of High Tech products, such as rapid and continuous changes in them, competition in product innovation, short life, the use of advanced technology and transformational management and leadership, the need to ensure product quality before delivery to the customer is of great importance. This guarantee is made by establishing a quality management system and observing the related requirements. This study aims to identify and rank the factors affecting the quality assurance of high-tech products with a structural equation modeling approach. The statistical population of this study was managers and quality control experts of engineering and turbine manufacturing companies. Structural equations and SMART PLS software were used to confirm the indicators and model fit. The study's findings indicate the identification of 21 indicators that, according to experts, are classified into five key factors. The results showed that all five factors significantly affected the quality assurance of High Tech products. Also, in the ranking, the quality control factor ranked first, the technical and engineering factor ranked second, the technology factor ranked third, the system process factor ranked fourth, and the leadership factor ranked fifth.

Keywords: High-Tech Products; Quality; Quality assurance(QA); Technology; Turbine Manufacturing.

1. Introduction

One of the most important goals of every organization and economic enterprise is to maintain the market share and continue to increase this share. Industries based on advanced technology are industries that are different from industries based on low and medium technologies in terms of products or processes, employees, or the amount of research and development, as well as knowledge. Thus, advanced technology based on products or processes includes diversity in production and continuous innovation. Based on the type of employees or the amount of research and development, it includes the use of skilled employees and high costs of research and development, and based on knowledge-based, it includes the use of knowledge-based, innovative and entrepreneurial technologies for human welfare [1]. The progress of advanced technology companies depends on their competitive advantage, type of technology and value creation through entrepreneurial ideas [2], which can lead to the production of an innovative product/service. If countries want to achieve economic growth, their companies must have the ability to produce an innovative product/service [3]. In general, quality assurance (QA) is a way to detect or prevent mistakes or defects in manufactured software/products and avoid problems when solutions or services are delivered to customers [4]. Companies and organizations seeking to establish or maintain their competitive advantage are forced to accept flexibility and change [5]. However, compared with traditional software systems, big data applications raise new challenges for QA technologies due to the four big data attributes (for example, the velocity of arriving data and the volume of data) [6]. Many scholars have illustrated current QA problems for big data applications [7]. For example, it is a hard task to validate the performance, availability and accuracy of a big data prediction system due to the large-scale data size and the feature of timeliness. Due to the volume and variety of attributes, keeping big data recommendation systems scalable is very difficult. Therefore, QA technologies of big data applications are becoming a hot research topic [8]. Therefore, a systematic study of QA technologies for big data applications is still necessary and critical. A Quality Assurance (QA) or Quality Management System (QMS) is a commonsense approach to organizing the business and support processes that affect the quality of regulatory and service delivery [9].

Engineering and turbine manufacturing industries are industries that have a lot to do with high-tech products, and the transfer of many technologies in the field of high-tech has been done; due to the high costs of these products, quality assurance in these industries is of particular importance [10]. Motivation Quality Assurance (QA) and Quality Control (QC) procedures are commonly used to verify and control activities [11]. Due to the production conditions of these products, which are not mass-produced and their production cost is very high, the quality category is of great importance, and some kind of guarantee of these products must be guaranteed [12]. There is no systematic literature review (including a systematic mapping study, a systematic study and a literature review) focusing on QA technologies for big data applications.

However, quality issues are prevalent in big data [13], and the quality of big data applications has attracted attention and has been the research focus in previous studies.

Today, organizations producing high-tech products are the main innovation base in societies and industries and constantly provide the ground for new demands and needs [14]. These demands, which stimulate investment, economic growth, and prosperity, are important in the industrial world. The research's statistical population, engineering and turbine manufacturing companies, are among the industries of power plant equipment manufacturing and energy supply [15]. Because these organizations are extremely technology-oriented and produce high-tech products, products have this feature. Quality control and quality assurance are also very important and necessary. Still, it seems that this company, despite being technology-oriented, has not comprehensively discussed the identification and factors affecting the quality assurance of its products. This vacuum and shortage are felt due to the effect of this factor on customer satisfaction and performance in the organization. In this study, we have identified these key factors and then ranked them. Familiarity with quality assurance and using them to increase and improve the quality assurance of their products [16].

TA tries to predict the direct or indirect implications of various technologies. In other words, it predicts and evaluates the implications and the impacts of different technologies on society and people. In fact, TA identifies the goals and policies to improve the desired outcomes and minimize unpredictable outcomes [17]. High-tech new ventures are established when entrepreneurs recognize an opportunity and create a high-tech idea, but new ventures will succeed when the entrepreneurs commercialize high-tech Entrepreneurial ideas [18].

2. Theoretical Foundations & Literature Review

There is no systematic literature review (including a systematic mapping study, a systematic study and a literature review) focusing on QA technologies for big data applications.

However, quality issues are prevalent in big data [19], and the quality of big data applications has attracted attention and has been the focus of research in previous studies. In the following, we first describe all the relevant reviews related to the quality of big data applications [20]. Systematically studied the challenges of data quality in the context of big data.

They mainly analyzed and proposed data quality technologies that would suit big data in a general context. They aimed to probe diverse components and activities forming parts of data quality management, metrics, dimensions, data quality rules, data profiling and data cleansing.

In addition, the volume, velocity and variety of data may make it impossible to determine the data Quality rules. They believed that measuring big data attributes is very important to the users' decision-making.

Fattahi [21] defines quality assurance as including all planned and systematic activities defined in the quality system that is used to prove the conformity of products or services with quality requirements. This method is proactive, and its basic premise is based on the principle that mistakes and errors are avoidable and can be prevented by systematic activities and identifying the factors affecting them. Najafi [22] has studied the effective factors affecting the management of quality assurance systems, such as determining training needs, determining motivational systems, measuring staff performance, and marketing HT products. Using statistical techniques and techniques to identify and analyze indicators such as the percentage of corrective actions, continuous improvement methods, and mold management, Lundgren [23]. Factors and engineering factors affecting the quality assurance of High-Tech products, including the analysis of measurement systems, analysis of potential failure cases and their effects, and research on product technical standards, have been studied.

Several studies were conducted in this regard inside and outside Iran, and the present article compares a few studies per Table 1:

Table 1. A Review of Domestic and foreign research

Research Year	Researcher's Name	Variables
2015	Mahsa Allah Yari Abhari Amir Najafi [24]	Improve the performance of the organization Strategic processes Research and development processes
2015	Arash Shahin Majid Ismailian Khorasani [25]	Leadership to decide Staff participation Continuous improvement
2015	Bahareh Farhangian [26]	Maintenance capability Stability Competitiveness
2015	Mehdi Goldoust [27]	Statistical methods of quality control
2015	Lundgren Magnus Mikael Hedlind Torsten Kjellberg [28]	MSA FMEA Process planning
2016	Gholamhossein Mehralian, Jamal Nazari, HamidReza Rasekh, Sajjad hosseini [29]	- Analysis and information - Management commitment - Relationships with suppliers - Customer focus - Human resources management - Alignment - quality guarantee - Quality system

3. Methodology

Since one of the research objectives is to identify factors and indicators, the research is exploratory. Since the research results can be used for engineering companies and turbine manufacturers, it is also applied according to the information obtained from company experts and professors. And data collection from within the organization is of a survey-descriptive type. Since the result of the research is to provide a structural equation model for engineering companies and turbine manufacturers, the research is a case study. Due to the limited statistical population, the counting method has been used. The data collection method used a questionnaire and interviews with experts. Also, using Cronbach's alpha, the reliability of the questionnaire was evaluated. Cronbach's alpha was obtained. By SPSS software is equal to 0.784, which indicates the internal correlation between the questions and, as a result, the existence of homogeneous questions. Experts also confirmed the validity of the questionnaire.

In this study, by studying the literature on the subject and summarizing the research and opinions of experts, 86 initial indicators have been identified. By designing a questionnaire with a Likert spectrum, the effectiveness of these indicators has been surveyed by experts. After the screening, 23 indicators were accepted. These indicators were classified into five factors. The main dimensions identified include engineering, quality control, system process, leadership and technology, based on which the final questionnaires were designed among 51 managers and quality experts of the company. Were distributed and collected, and the research model was fitted using structural equations and Smart Pls software.

- Statistical population of the research

The study's statistical population includes 51 managers and experts in the quality of turbine engineering and construction companies with bachelor's and master's degrees with more than five years of work experience. Due to the limited statistical population, a purposeful and available sampling method has been used. The characteristics of the statistical community are shown in Table 2.

Table (2). Profile of statistical population

Level of education	rate	Frequency percentage
Bachelor	31	61%
Master	20	39%
total	51	100

4. Summarizing the research findings

4.1 Analysis of the first research question

A questionnaire containing 23 items was employed to approve the theoretical model of the research. The results of the validation of the research model were analyzed in SmartPLS. Figure 1 shows the research's theoretical model, which indicates the research's primary structural model plus factor loading coefficients. The appropriate value for acceptance of the factor loadings was 7. All indices with factor loadings of less than this value were eliminated. Figure 2 shows that for the research model to be homogeneous, two indices of QC4 and SP5 were eliminated, and the approved model was obtained through coefficients of the factor loadings presented in Figure 2. The approved research model was achieved using significance coefficients presented in Figure 3.

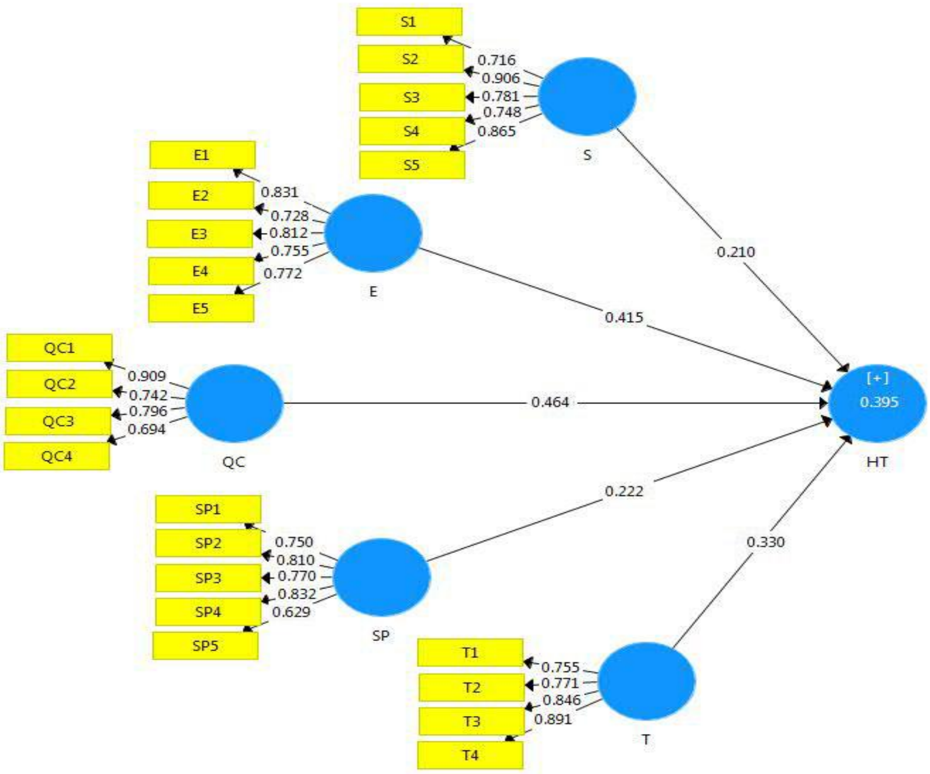

Figure 1. Primary Measurement Model of the Research Plus Factor Loading Coefficients

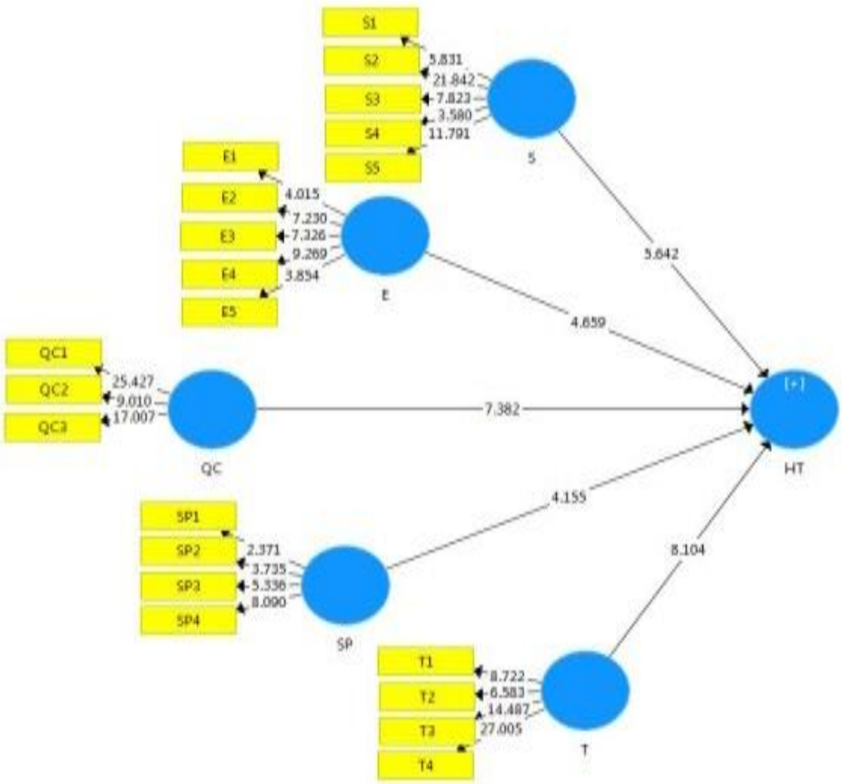

Figure 2. Approved Model of the Research Plus Factor Loading Coefficients

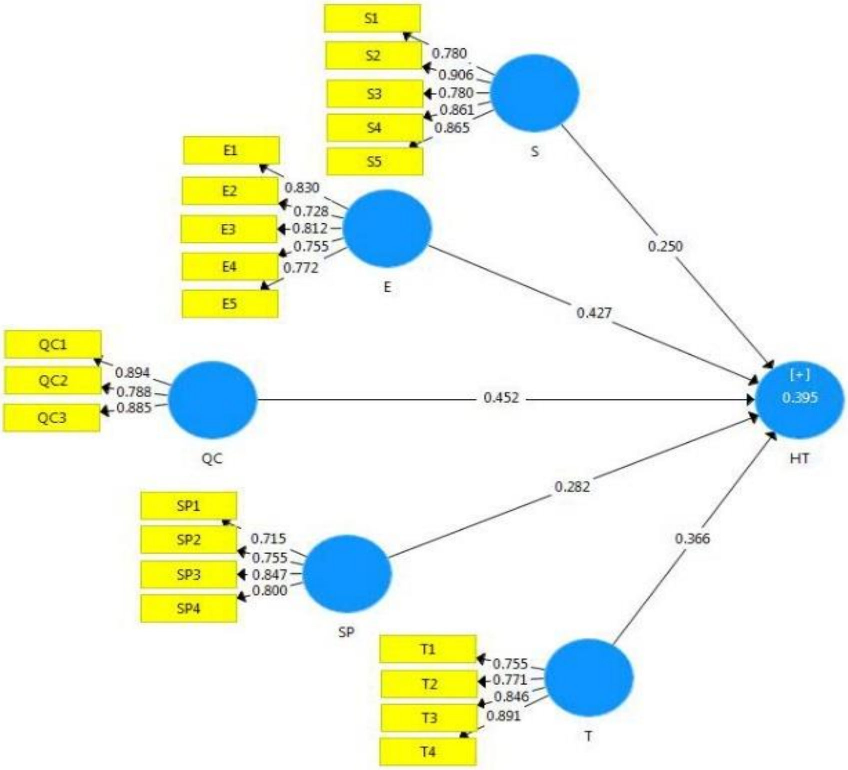

Figure 3. Approved Model of the Research Plus Significance Coefficients

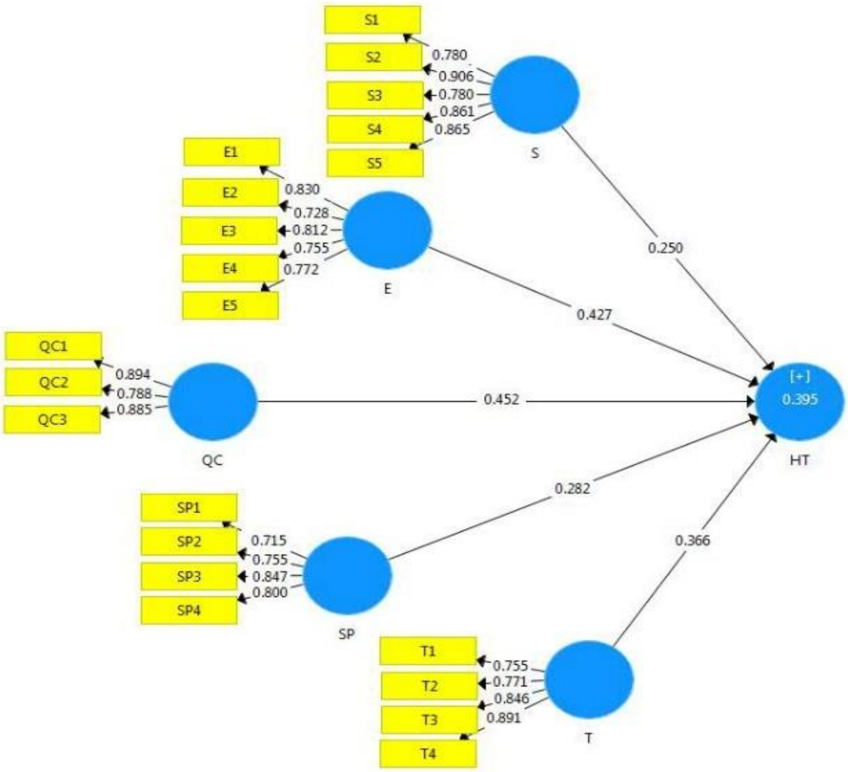

Figure 4. Approved research model with significant coefficients

The following are the results of all tests of reflective measurement, structural, and general models.

Reflective measurement model analysis:

1. Homogeneity test, the condition for accepting this test is that the factor loads of the indices should be greater than 0.7, which in this model are removed because the two indices have a factor load of less than 0.7.
2. Reliability test, which includes Cronbach's alpha, combined reliability and shared reliability. The acceptance condition of Cronbach's alpha and combined reliability is that it is above 0.7, which is accepted in this study for all indicators, and for shared reliability, the acceptance condition is greater than 0.5, which is accepted in this study for all indicators.
3. Validity test: which includes tests related to convergent validity and divergent validity:
   3.1. Convergent validity: a) Significance of factor loads where the value of t.value should be greater than the absolute value of 1.96 and is confirmed for all indicators. B) The homogeneity of all operating loads after fitting is greater than 0.7, which is confirmed for all indicators. C) AVE, which must be greater than 0.5 and approved for all agents. D) CR> AVE, where the combined reliability value for all factors should be greater than AVE, which is confirmed for all factors.
   3.2. Divergent validity: a) Transverse load tests in which the factor load of all observable variables on the corresponding hidden variable is at least 1. More and in this research is accepted for all factors. B) Fornell-Larker test in which the AVE root for each factor must be greater than the correlation of that factor with other reflective factors in the model, which is confirmed for all factors. The value of 02. Weak 15. Moderate and 35. Strong is measured. In this study, the quality of the measurement model is strong for all indicators.

4.2 Structural model analysis

1. Significance factor: The value of t.value for all relations between independent and dependent variables is greater than the absolute value of 1.96 and is confirmed for all relations of the research.
2. Determination coefficient (R2): The coefficient of determination is measured with values of 0.67 strong, 0.33 moderate and 0.19 weak. The value of 0.39 indicates a coefficient of determination above the average in this study.
3. Prediction coefficient (Q2): The values of 0.35 are strong predictions, 0.15 are moderate predictions, and 0.02 indicate the weak predictions of the model, which is 246. Indicates a coefficient of determination above the average in this study.

4.3 General model analysis

GOF: Values of 0.35 are strong, 0.15 are moderate, and 0.02 are weak. The value of 0.223 indicates that the overall fit of the research model is above average. According to the above measurements and results, the status of indicators and factors affecting the quality assurance of HT products is in accordance with Table 3.

Table 3. Indices & Factors Affecting Quality Assurance of High-Tech Products

Factor	Code	Index	load factor	r2	ranking
Engineering E	E1	Reliability	0.831	0.69	First
	E2	Measurement System Analysis (MSA)	0.728	0.52	Fifth
	E3	Failure Modes & Effects Analysis (FMEA)	0.812	0.65	Second
	E4	Product Development	0.755	0.57	Fourth
	E5	Product Technical Standards	0.772	0.59	Third
Quality Control QC	QC1	Control Plan	0.909	0.82	First
	QC2	Calibration	0.742	0.55	Third
	QC3	Quality Problem Records	0.796	0.63	Second
System-Process SP	SP1	Packaging Standards	0.75	0.56	Fourth
	SP2	Corrective Actions	0.81	0.65	Second
	SP3	Key Properties of Processes	0.77	0.59	Third
	SP4	Continual Improvement	0.83	0.68	First
Technology T	T1	Product Life-Cycle	0755	0.57	Fourth
	T2	Software Settings of Devices	0.771	0.59	Third

	T3	Mechanical Settings of Devices	0.846	0.71	Second
	T4	Technical Properties of Product	0.891	0.79	First
Strategic S	S1	Human Resources Training	0.716	0.51	Fifth
	S2	Personnel Efficiency Measurement	0.906	0.82	First
	S3	Determining Training Requirements	0.781	0.60	Third
	S4	Determining Motivational Systems	0.748	.0.55	Fourth
	S5	Quality Management System Development Percentage	0.865	0.74	Second

Finally, the research model, after fitting based on Table 3, was obtained in Figure 5.

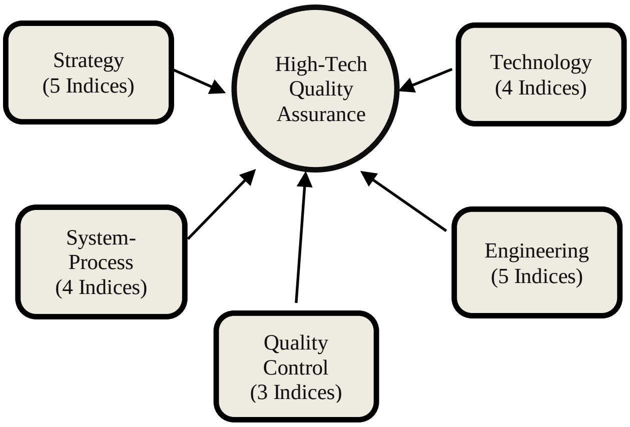

Figure 5. The final research model

4.4 Findings from the second research question:

Considering the output of SmartPlS software, the effective factors were ranked concerning the coefficient of determination (R2). In fact, the coefficient of determination demonstrates the effect of the independent variable in explaining the dependent variable. Therefore, Table 4 and Diagram 1 show the ranking of each underlying factor of QA.

Table 4. Rankings of Factors Affecting QA of High-Tech Products

Path	Code	Path Coefficient	R^2	Rank
Quality Control	HT---QC	0.45	0.204	First Rank
Engineering	HT----E	0.427	0.182	Second Rank
Technology	HT----T	0.366	0.133	Third Rank
System-process	HT----SP	0.282	0.079	Fourth Rank
Strategic	HT----S	0.25	0.062	Fifth Rank

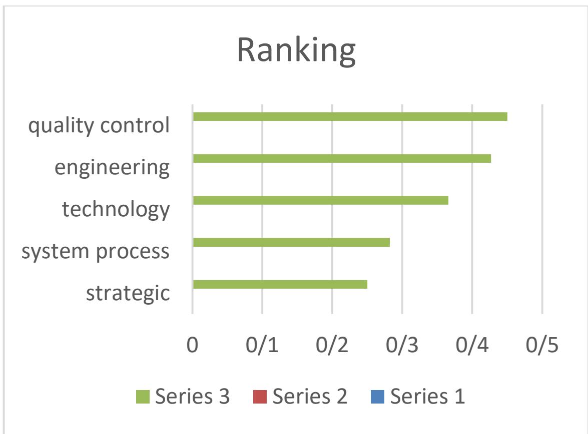

Figure 6. Ranking of factors affecting the quality assurance of High Tech products

5. Results & Conclusion

The present research revealed that five factors affect the QA of high-tech products: QC with three indices, engineering factor with five indices, technological factor with four indices, system-process factor with four indices, and strategic factor with five indices. The QC and engineering factors ranked first and second, and the other factors attained the subsequent ranks. The present research offers the following proposals in Table 4:

The QC factor obtained the highest r^2 and ranked first. Recruiting trained and proficient personnel is recommended to control the products more precisely and desirably per the technical plans and standards. This recommendation is also cost-effective considering task duplications, wastes, and pauses of the devices, making the index move closer to the desirable status. Besides, it is suggested to reduce the duration of the calibration courses of all gauges and measurement and test equipment pieces employed in the laboratories, inspect the input items, and carry out the during-process inspection and final inspection of the tools, molds, and fixtures to ensure that the product corresponds to the defined needs.

The engineering factor obtained the second r^2 rank. The measurement systems index attained a lower score than the other indices. To improve this index, it is recommended to invest more in the supply of more precise control tools to improve the reproducibility and replicability indices and enhance the capability of the tools. Reducing the development cycle of new products can be considered regarding the product development index (the product development process should be reduced to the minimum). Utilizing management knowledge in product development is recommended to accomplish this goal.

The technological factor ranked the third r^2. It is recommended to employ more modern technologies such as Nanotechnology and, in this regard, the information and knowledge of other knowledge-based companies should be used, which requires budget allocation.

The system-process factor ranked the fourth r^2. The problem-solving methods can be used to resolve various problems and issues. Furthermore, to utilize these methods, the knowledge regarding statistical analysis and the use of statistical indices must be internalized in the company. The packaging index obtained a lower score than the other indices. It is thus recommended to use the modern packaging standards of the world (GALIA standard). For the index of key characteristics of the process, it is recommended to use the matrix of important characteristics of the product/process to extract these features. It holds the required training courses for the employees.

The strategic factor ranked the last r^2. To increase the employees' motivation, a plan of the roadmap to their progress was provided so that future employees can imagine their future based on their efforts. It is recommended to use job rotation to develop the employees' multiple skills, which can increase their efficiency. To improve the training index, it is suggested to train strategic management and risk analysis issues to all employees, even the management, following the latest version of Iso 9001:2015.

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