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IMPACT OF TCHNOLOGY ON TOTAL QUALITY MANAGEMENT AND ITS OPTIMAL IMPLEMENTATION IN AUTOMOTIVE INDUSTRY (CASE STUDY: IRAN KHODRO CO.)

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ABSTRACT
Current research study aims at describing technology role in optimal implementation of Total Quality Management (TQM). Thus, firstly TQM and its tools, principles, scope, and basic elements of TQM are described. On the other hand, technology and its four elements (human ware, techno ware, orga ware, and info ware) are introduced. Following introduction of technology and TQM, convergence of both concepts is investigated. That is, it is examined how each of four elements of technology influences TQM and its optimal implementation. For example, expert people can implement TQM better by training, or information collected in the organizations can be entered into software systems and various reports can be obtained by TQM tools including cause and effect diagrams, Pareto charts, histograms, and fishbone. Analysis of these reports provides good results and decisions for optimal implementation of TQM. Also, techno ware element and equipment are explained. That is, how it can help TQM implementation. For example, equipment called robot can produce pieces in higher accuracy and increases output quality of the products which ultimately leads to qualitative standards for the organization. In addition, the organization element helps excellence by obtaining ISO and quality standards. Finally, Iran Khodro Co. is selected as the case study and it is explained how this company could utilize technology elements in press shop, body shop, paint shop, trim shop, and final audit units to optimally implement TQM and how it could achieve competitive advantage within ten years by implementing these cases.

Keywords: Total Quality Management (TQM), Techno Ware, Orga Ware, Info Ware, Human Ware, Quality Elements, Technology

INTRODUCTION
Human being has been dealing with quality since the beginning of the creation, for example, in building his home and residential place and in recognizing suitability of his arm and defense tools. By extending scope of human needs and then creation of markets for goods and service exchange, and quality control concepts were raised, and then it became the basic and influential factor in goods production and service delivery. Undoubtedly, quality control history is as old as the industry history. During middle Ages, quality was controlled by holding long term courses of trainings by castes. Labor specialization concept was developed during industrial revolution. Since then, the worker produced only part of the product instead of producing the whole product. This change reduced role of skill in production of the whole product. Since most manufacturing products were simple in the early periods, the quality was not much influenced. More complex products were gradually entered and the profession got more specialized, and product inspection after production necessitated. In 1924, Shivhart prepared statistical graph from Bell Telephone Laboratories for controlling product variables. In 1946, American Society for Quality Control was established. In 1950, Edward Deming offered a series of lectures on statistical methods for Japanese engineers. By 1960, the first quality control circles were formed to improve quality. In the late 1970s and early 1980s, Americans had many trips to Japan to learn the Japanese miracle, and finally, in 1980, the auto industry began to focus on statistical quality control. Suppliers in this industry were bound to use these methods. Other industries and defense sector also used statistical control process. In addition, new concept of quality became evident, requirement of which was TQM. To ensure that the products and services enjoy designed quality, qualitative commitment is necessary in the whole organization. Such attitude to quality management is manifested in the organization as total quality management.

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Review of Literature

TQM Definition: It realized basic principles of quality guarantee, total quality management, and quality control in the whole company. TQM stresses on the top management role in directing qualitative endeavor of all staffs at all levels. All employees are responsible for continuous quality improvement and quality is the main factor in all organizational tasks. TQM also stresses on the fact that quality is a strategic concept. The organization should specify that what the customer wants from quality and then use strategic planning which includes all operational sectors so that qualitative goals are achieved. In fact, all activities in the business are part of the interactive process or process group which has been done repeatedly, and business is not merely a separate task group [8].

TQM principles include:

1. The customer determines the quality and customer needs are top priorities.
2. Senior management must take the responsibility of quality leadership.
3. Quality is strategic.
4. Quality is the responsibility of all employees at all levels of the organization.
5. All functions of the company should focus on continuous quality improvement to achieve strategic objectives.
6. Quality problems must be resolved with the cooperation of management and employees.
7. Statistical quality control methods should be used for problem solving and continuous quality improvement.
8. Training and education of all employees is the basis for continuous quality improvement [8].

Scope of TQM

TQM covers three concepts of management, quality, and comprehensive.

Management: Although generally it means the way of administration and control, management in this system is based on a special style; the style which is mostly prospective and guiding rather than being passive and commanding.

Quality: In this system, quality is defined by focus on customer demand and its continuous improvement is a main point [8].

Comprehensive: This term means thorough and perfect and it denotes that scope of this system is all aspects of business and all stakeholders. In total quality management system, management and administration of the organization is considered for achieving excellence resulting from quality. Achieving to this excellence is possible through a collection of actions which are systematically interacted, and utilization of them influences all scope of the organization. Besterfield classifies these actions in two classes: principles and activity, tools and techniques, with their own elements. In this classification, principles and activities include leadership, customer satisfaction, employee participation, continuous improvement, supplier partnership, and performance measurement. Tools and techniques are classified into qualitative and quantitative groups.

Quantitative techniques include statistical process control, acceptance sampling, reliability, test designs, role rate analysis and development of qualitative needs, and qualitative techniques include ISO9000, ISO 1400 standards, patterning, comprehensive repair and maintenance, management tools and concurrent engineering [8].

It also covers following cases:

Leadership, strategic process planning, output quality assurance, suppliers' quality assurance, major innovations, analysis of data, human resources utilization, customer satisfaction, and qualitative results [10].

TQM is in fact a management philosophy which attempts to achieve long term success in customer satisfaction areas. In TQM, all organizational elements participate in the improvement processes including products, services, and cultures. The methods for implementation were provided by Philip Crosby and W. Edwards Deming and other scientists [10].

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Basic Elements of TQM

TQM can be summarized as management system for focus on customer which includes improvements in all employees of the organization. Effective strategies, information and communications are used in TQM. Ideal elements of TQM include:

Focus on customer: It is the customer which ultimately specifies limits of quality and it is not important in the view of customers that if the organization of quality improvement system has training program for its employees, if it upgrades its software systems, and if it purchases new measurement equipment. The customer finally decides based on the output product quality. Internal processes are not much important for the final customer.

Focus on the processes since beginning to the end: the basis of TQM focuses on the processes; processes are a series of activities which initiate from internal and external suppliers and extend to the end of production lines where the final products are produced.

Involvement of all organization's employees: All employees of the organization took part in order to achieve a common goal.

Continuous improvement: The main item in TQM is continuous improvement of the processes. Continuous improvement causes that organizations achieve new ways for gaining competitive advantages [10].

TQM Tool

TQM tool helps organizations in qualitative and quantitative recognition, analysis, and evaluation of information related to their business. These tools may specify processes, ideas, statistics, reasons and effects for the organization, and each of them can cause increased efficiency and effectiveness and standardization of qualitative processes of the products or work place. The number of qualitative tools is about 100, for example: brainstorming, team groups, checklists, charts, graphs, diagrams, and other analysis tools (according to SQ 2004 standard). TQM tools describe complex information in the following cases:

1. Identifying your goals
2. Evaluating customer needs
3. Competitive analysis
4. Market analysis
5. Brainstorming ideas
6. Changes in productivity
7. Work flow statistics and employee job descriptions
8. Work flow and employee job description analysis
9. Financial analysis
10. Understanding models
11. Commercial structure
12. Logical analysis [10]

Technology Impact on TQM and Its Optimal Implementation

First we provide a definition of technology. Technology means application of knowledge for solving scientific problems and changing the nature. In other words, technology is a manmade phenomenon composed of two main components: hardware and software. Hardware includes any material tool and means and software includes the knowledge for performing the work or techniques for utilizing the tools. Technology is combination of software and hardware in varying degrees. It is the most powerful factor for change in the society and its progress is an ongoing process. Since technology is considered as the main core of development system, its changes influence all elements of the system and thus it is a tool which constantly reshapes the communities by its ongoing changes [2].

Four Main Elements of Technology

Technology as the factor which turns production factors to the goods and services include four elements:

1. Info ware
2. Human ware

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3. Techno ware
4. Orga ware

Four elements of technology interact with each other and mutual interaction and suitable and continuous progress of these elements develops the technology. Four elements of technology cause transformation of natural resources and mediatory goods to product and services and no transformation is possible without presence of these four elements. Technology does not have any property per se and everything depends on the way of utilizing technology [9].

Impact of Technology Elements on TQM's Optimal Implementation
Role of Integration between TQM and Technology Management
By recognizing technology and its elements, it is investigated that how technology and its progress influences TQM implementation. Technology development can create added value in the organization only through convergence with other systems existing in the organization. Technology convergence concept means: convergence between research, production, and administrative areas in the organization. Realization of such convergence can increase learning power of the organization. Also, it increases competitive capacity in business environment through promoting innovation. Convergence between TQM and technology management was firstly introduced by Boner and Tashman. They examined and demonstrated relationships between TQM and research facilities in the organization, especially in relation with process management and costumer focus. They argued that process management is focused on development, progress, and improvement in the organization and it is done through preserving new and specialized skills which can be implemented in all organizational activities using existing facilities. It is strongly associated to costumer-orientation principle, in which the organization focuses on increasing understanding of the customers and trying to fulfill their needs. They concluded that the organizations should move for producing high quality products which can fulfill customer needs.

In TQM literature, the issues about technology management have been specifically considered. In this regards, techniques and tools such as statistical process control (SPC), seven tools of quality control, quality function development (QFD), Failure Mode and Effects Analysis (FMEA) can be mentioned. Heatherton and some authors emphasized positive relationship between TQM and advanced manufacturing technologies (AMT). Zaeeri proposed that TQM and AMT integration can direct organizations toward development and improvement of conditions for world class competition which is based in presence of innovation in the organization. They maintained that TQM has more important role in the companies which use such strategies as distinctive product manufacturing in competitive environments compared to the companies which mostly use defensive strategy and focus on cost reduction or increased manufacturing capacity. Such concepts as technology management had no place in the past in TQM literature. None of TQM pioneers such as Deming, Juran, or Crosby specifically considered R & D role quality management concepts [15].

Role of Technology Elements in TQM
Impact of Techno Ware and Info Ware on TQM
Aspects of total quality management:
1. Senior management support
2. Customer relationship
3. Suppler relationship
4. Human resource management
5. Characteristics and behaviors of employees
6. Product design process
7. Production process management
8. Quality Assurance Unit

Now impact of technology information on these aspects is examined.
Information technology includes a collection of techniques and tools which are used for optimization and support of systems active on information and knowledge. It also includes studying, designing, developing, implementing, maintaining and managing computer based information systems and especially computer

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software and hardware applications. In this section, impact of information technology on the mentioned aspects is investigated.

Information Technology and Senior Management Support

Senior management support is necessary for successful implementation of TQM as well as application of information technology. In some cases, use of information technology tools creates some problems among employees. In this case, intelligence of the senior management is necessary for preventing from conflicts in information technology demands and TQM philosophy. In most cases, information technology leads to reduction of employees and their fire, which can be coped with by development of the company or setting regulations such as early retirement.

Information Technology and Customer Relationship

Information technology development helps improvement of customer relationship. It can lead to creating direct relationship between companies and their customers and help information exchange between them. Information technology provides access to customers which are distant geographically to the company and generally it is regarded as an opportunity for the companies. Understanding speed and development of e-commerce between companies and countries is very important. For example, the companies can communicate with their customers by offering their products via internet (so that characteristics of the product are completely described). Also, customers can purchase their respective products in the same way and express their ideas and complaints. Companies can produce products fitted to customer needs and expectations using information technology and storing information received from customers and their advanced analysis. Using Electronic Data Interchange (EDI) with customers allows companies to have effective communications with their customers (considering product characteristics, ideas, recommendations, and complaints). Thus, information technology is a powerful tool in customer relationship management (CRM).

Information Technology and Supplier Relationship

As mentioned in the previous section, information Technology can help development of relationship with the suppliers. Electronic Data Interchange (EDI) is used in order to order products, send product features, send design details, receive and confirm bills and bill payment. Using information technology, suppliers can have quicker design process. In some cases, companies can have access to their suppliers' inventory system or production planning systems and they can order products automatically. Overall, information technology helps facilitation of relationship with suppliers and reduction of the number of suppliers.

Information Technology and Human Resource Management

Use of information technology causes change in working skill of people. Thus, training employees is more important in this case. On the other hand, information Technology should be used in such a way that efficiency, creativity, job satisfaction and flexibility is maximized. To this end, information Technology should be used for completing and improving tasks.

Information Technology and Characteristics and Behaviors of Employees

When new information Technology based systems are utilized, use of reorganization is necessary, but employee resistance against changes is natural. Thus, the employees should be aware of the benefits of implementing new systems. If the employees are informed that information technology is used for eliminating risky and tiresome tasks and facilitating works, not only they do not resist against changes, but also loyalty, working proud, and job satisfaction is increased.

Information Technology and Product Design Process

Use of information technology may bring about innovation. Computer aided design (CAD) technologies considerably help design process, because it leads to quicker fulfillment of customer needs and innovation in the product design. Designing new production an efficient manner and process development require information from different parts such as production, marketing, R & D, and information technology helps more effective and quicker information transfer. Considering internet applications, various groups throughout the world can took part in product design process. Information technology plays significant role in design of experiments (DOE), Failure Mode and Effects Analysis (FMEA), Quality Function

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Development (QFD). In all cases, information technology does not change the way of implementing these tools, rather it helps simplification of their application and creating new ideas.

Information Technology and Production Process Management

Use of information technology in repair and maintenance systems is very effective. In this case, repair and maintenance needs of the machineries are specified using automatic systems. On the other hand, automation helps reduction of process scattering and it leads to increased quality. It does not mean that need for quality management is eliminated, rather considering the fact that automatic machines need higher quality raw material and elements, such need is felt more than ever. Statistical process control (SPC) becomes more simplified using measurement of parameters and product characteristics by automatic tools. For companies with quality system certificates such as ISO 9000 use of software helps them in planning the system and internal auditing.

Information Technology and Quality Assurance Unit

Role of quality assurance unit does not change by application of information technology, rather freedom of action, access to senior management and cooperation with other units is yet established. Overall, information technology simplifies task of quality assurance unit, since data collection and analysis and its transfer to other units is done quicker and more accurately. Cases such as purchase, sale, quality control, etc. require information which their information systems provide timely and optimally. The main constituents in information system design are database. Database is consisted of information elements in the form of records and files and they are organized in such a way that they meet information needs of the users. In this case, quality assurance unit should solve problems and issues resulting from information technology in such a way that TQM philosophy's principles are not damaged. Progress in the organizations should be due to changes in the organization, not changes resulting from employee control. According to Deming, progress resulting from organization process changes is the key for development of team cooperation. Deming states that if the management imposes its control on the employees as the past, it is difficult way to create cooperation and teamwork sense. In addition, Deming maintains this state creates fearful working environment for employees where they avoid risk taking except when works are done individually [1].

Impact of Human Ware on TQM

According to Deming, progress resulting from organization process changes is the key for development of team cooperation. Deming states that if the management imposes its control on the employees as the past, it is difficult way to create cooperation and teamwork sense. In addition, Deming maintains this state creates fearful working environment for employees where they avoid risk taking except when works are done individually. According to other experts, management should exit from traditional and individual manner and it should be shifted to process-oriented or team work in TQM. Western management generally should avoid control over implementation in individual manner, even in the organizations where TQM is totally established. Organizational implementation control is a process which supports cooperation among different teams of supporters and customers and development of an open and positive organization.

Hard Aspects of HRM

 Hard aspects of HRM stress on quantitative, computational and commercial aspects in a logical way such as other economic factors. Hard aspect of HRM is compatible with the business based philosophy which emphasizes employees should be managed in such a way that they can produce added value, and thus competitive advantage can be created for the organization. Business based philosophy views employees as human capital which can brings profit by investing on it (training and development of human capital). Hence, employees are viewed as a source which should be used like other resources for maximum gain.

Soft Aspects of HRM

Soft aspect of HRM originates from such concepts as human relation school, emphasis on communication, motivation ad leadership. As Striey puts it, soft aspect of HRM includes treating employees as valuable assets, viewing employees as mean and not goal, and considering their skills as source of competitive advantage for the company.

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According to Guest, employees should be viewed as means not as goal. Such attitude toward human resource emphasizes on obtaining and attaining spiritual commitment of employees through participating them, communication, and other appropriate methods. Also, key role of organizational culture is emphasized.

Assimilating Soft Aspects of TQM Based on Soft Aspects of HRM

If customer satisfaction aspect in soft aspects of TQM is put aside, a one-by-one contrast is obtained between other indexes in soft aspects of HRM and TQM [1].

Impact of Orga Ware Element on TQM

Individual knowledge is necessary for basic organizational knowledge development, although organizational knowledge does not result from simple summation of individual knowledge. Interaction between technology, techniques, and human being deepens knowledge management concept, because the pattern of interaction between technology, techniques, and human being is unique for every organization which is not easily exchanged or imitated by other organizations. Overall, the organizations have underlying and background knowledge. Achieving, formulating, regulating, and copying underlying knowledge is easy, while imitating background knowledge is difficult because of being implicit. It depends on the organizational history. Although we argue that it is not the underlying knowledge which enables an organization to achieve better performance and implementation. In fact, it is the relationship and coordination between underlying and background knowledge which shapes capability and efficiency of the organization and leads to its excellence (Journal of Information Sciences). Generally organizational knowledge should be used for products, services and process of the organization. If the organization is not able to specify proper form of the knowledge in its due place, it would face problems in competitive areas. When innovation and creativity is the path for wining in today world, the organization should be able to utilize appropriate knowledge at suitable place. Organizations have different ways to utilize their knowledge resources. For example, existing knowledge can be obtained from various internal contents, appropriate measurement standards can be adopted, people can be encouraged and trained to think creatively, and use their understanding for improvement of the organization's products, services, and processes. For example, Chevron Oil Co found that it can annualy save 20 million dollars by creating a data collection team in its oil area. Knowedlge application concept is associating and activating exsiting knowedlge in order to add values [8].

Human resource unit can help the company in achieving competitive advantage and creating added value and implementing total quality plans. Thus, quality improvement depends on presence of employees with high competencies at all levels. This competency has following roles in total quality"

A. It participates in design and development of a total quality approach in the whole organization.

B. It identifies internal customer needs for human resource services and meets their needs.

C. It appreciates total quality and pays attention to continuous improvement of its working methods.

D. It promotes total quality and encourages for continuous performance improvement [16].

E. Case Study: Iran Khodro Co. and Role of Technology on Optimal Implementation of TQM

As defined, TQM is a management tool, thus it both utilizes tools existing in the organization and causes their improvement. The first step in TQM implementation is proper data collection from internal processes of the organization. To this end, such tools are needed so that it is ensured that collected data are correct. If data are collected manually, assurance of the data accuracy is a management challenge. In fact, motivational and controlling approaches are needed in human resource discussion so that it is ensured data collection is done properly. The other important step in TQM is data analysis which is done by the experts. Management of knowledge oriented forces is the other challenge for management. Implementation of the necessary activities challenges the whole organization and sometimes it extends to reengineering of the organization or BPR. Mentioned tools and techniques of TQM utilize and take benefit of accuracy of collected data and proper data analysis, which requires management skills. The major business of Iran Khodro Co. is manufacturing automobiles with determined specifications. Automobile manufacturing process is in this way that some necessary pieces of the automobile are manufactured inside the company, which are mainly large pieces such as engine lid and trunk. Other

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pieces are produced by the external manufacturers and are delivered to Iran Khodro Co. these pieces should be transferred to assemble lines from stores. Manufacturing process initiates from pressing unit. As mentioned, some large pieces of automobile body are made of raw sheets by large molds. All pieces related to body are assembled by machines known as JIG and Fixture. For example, SAMAND body production line has over 200 JIGs. Then total automobile body is transferred to coloring unit and it is colored within several stages. Then, the automobile is transferred to the assembly unit and all non-body pieces such as wheels, engine, seats, interior decoration, and lights are assembled. Finally, the automobile is put under final quality control and it is sent to the store for delivery to the customer. As mentioned, data collection is one of the TQM steps. It is done in various steps of production in different ways. For example, in pressing unit, sensors sensitive to the metals count the number of manufactured pieces. Quality control is pursued in higher accuracy in body making unit. In this unit, there is a tool known as CMM (three-dimensional measurement) as well as portable measurement machines made by Romer Co. which control and report different geometric dimensions of the assembled pieces. In addition, there are various machines by which the trained personnel control different parameters in the automobile. There are computers and specific software in data analysis unit which are helpful. 3D measurement tools are equipped with software which are given along with the tool by the manufacturing company, and they are responsible for analysis of data collected by CMM. Output of these software is in the form of Pareto charts, histograms. Or circle diagrams. In addition, statistical software such as Minitab with its embeded algorithms are able to analyize entered data.

Minitab software is a powerful tool which includes options for drawing Ishakawa diagram and fishbone diagram and it is able to perform almost all statistical analysis. In the step of implementing defined activities, such tools as robots and automatic material transfer machines increase quality of pieces. In addition, all mentioned equipment and software are controlled by expert forces which have passed various courses. All experts, technicians, operators, managers, and authorities of Iran Khodro Co. have took part in various courses such as Six Sigma, SPC, 5S, technical drawing with AutoCAD and CATIA, specialized courses on mold design, jig, fixture, commercialization, quality, production management, kaizen, lean manufacturing, techniques for identifying Moda and removing them, problem-solving techniques, TRIZ and creativity, and kinds of special software, repair and working with robots, implementation of new projects, project management, and management courses including crisis management, stress management, industrial psychology, industrial management and various kinds of courses that each person spends according to his specialty.

All above mentioned trainings suggest considerable role of human resource (human ware) and data obtained by these forces in Iran Khodro Co which helps optimal implementation of TQM in the organization.

With proper and systematic implementation of regulations and rules and obtaining various required standards including ISO, Environmental Standard, HSE Safety Standard, etc., the organization moves toward optimal implementation of TQM along with other elements which directs it toward excellence.

Finally all four elements of technology (human ware, info ware, techno ware, and orga ware) creates competitive advantage in Iran Khodro Co. because they all move within the same direction together, and it causes this company witness considerable progresses especially in 2000s. Now this company is able to match to the great companies in the world and implement all activities since beginning to the end in some automobiles independently, and even it can export technology to other countries in some cases.

RESULTS AND DISCUSSION
Results and Recommendations
It is found that for ensuring quality in the products and services, competitive advantage should be created in all affairs of the organizations by proper implementation of TQM. TQM realizes basic principles of quality assurance, total quality control and quality control in the whole organization. TQM emphasizes on role of senior management in directing qualitative affairs of all employees. All employees are responsible for continuous quality improvement and quality is the main factor in all organizational tasks. TQM also

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stresses that quality is a strategic concept. The organization should determine what is the need of customer and then customer needs and qualitative goals should be achieved by proper implementation of TQM.

Thus, if the case company (Iran Khodro Co.) wishes to adopt the quality asked by the customer in all its affairs, following cases are recommended:

1. It should identify all four elements of technology accurately and use them for optimal implementation of TQM. It is suggested Iran Khodro Co. uses appropriate technology in its processes in order to better implementation of TQM. In fact, it should use the technology which is suitable to its organizational structure and culture and employees and fitted to its goals, not more or less, because if complex technologies unmatched to the organizational infrastructures are used it would lead to easting resources.

2. Regarding use of expert forces (human ware aspect of technology), it is suggested to train human resource (technology's human ware) in Iran Khodro Co. professionally. To this end, the company should adopt open innovation, i.e. communicating with all external research centers. The company should improve its relationship especially with academic centers and promote such measures and internship projects and shared projects with other research centers.

3. In info ware area, it is suggested that Iran Khodro Co. concludes contracts to domestic knowledge-based companies in order to acquire and promote info ware, specialized software, and necessary trainings in the organization, so that support problems are eliminated in case of technical communication problems with other countries.

In learning area in systemic and standards (orga ware), it is recommended that Iran Khodro Co. dispatch its systemic expert forces for learning to specialized training centers so that they are trained.

4. In equipment purchase area (hardware), it is suggested when purchasing equipment needed in mechanical, etc., cases related to software and hardware equipment support are comprehensively discussed in the contracts so that intellectual ownership problems do not occur in the future, and the organization is legally able to demand support affairs from external supplier.

5. Finally, it is suggested for better implementation of TQM, all four aspects of technology is optimally used so that Iran Khodro Co. achieve its qualitative and quantitative goals and it can improves its status in global automotive industry by acquiring competitive advantage and accurate implementation of TQM.

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