Applying Total Quality Management Tools Using QFD at Higher Education Institutions in Gulf Area (Case Study: ALHOSN University)

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Abstract: Human power's quality plays the key role in the growth and development of societies where the quality of human powers can be enriched with the high quality education provided by the higher education institutions. The higher education institutions are hereby an important sector of any society since it defines the overall quality of human lives. This research will investigate the application of Total Quality Management (TQM) tools at the higher education institutions; specifically at ALHOSN University. In this study five tools were implemented at ALHOSN University's engineering college including: Quality Function Deployment, Affinity Diagrams, Tree Diagrams, Pareto Charts, and Fishbone Diagrams. The research will reveal that the implementation of TQM tools has a great benefit for higher education institutions where they have uncovered many area of potential improvement as well as the main causes of some of the problems the Faculty of Engineering is facing. Also, it will show that the implementation of TQM tools on higher education institution systems will enhance the performance of such institutions.

Key words: Quality function Deployment, Higher education, Total Quality Management.

1. Introduction

The construction of a modern and knowledgeable society requires governments to draw their attention on the type of education provided to their society. This would certainly require governments to devote their efforts and resources in achieving an educational system of high quality. Governments around the world are trying to develop strong relationships between the education sector and the society (Zaman, 2016). One of the ways in which educational systems at higher education institutions (HEI) can be developed and improved is the use and implement of Total Quality Management (TQM) tools.

Higher education is now a real part of the globalization process in which supply and demand are matched, Qureshei *et al.,* 2014. Higher education institutions are institutions which seek to achieve defined objectives and goals in their academic, research, and community development aspects. This has given the institutions' achievements in science, technology, and services a high importance because of the benefits such achievements have on graduates and society which puts higher education institutions under more pressure to enhance their abilities in adaptation and development in respect with the fast development in both education and technology (Abou Chahine *et al.,* 2008)

The usage of such tools would give the higher educational institution a strong position among other educational institutions since it would afford a higher quality educational system in the competitive field the higher education institution is being competent in. In order to assure that the institution is being competitive enough, total quality management tools allows institutions to review and assess their performance to see whether

they follow the required conditions of learning and teaching (Tarawneh and Mubaslat, 2011). The application of total quality management is done through using qualitative and quantitative tools as means for higher education institutions to assess the performance of the educational institution where they can define their strengths in order to enhance it and their weaknesses in order to eliminate them. Besides, the institution needs to take into consideration the improvement for the institution over time, and compare its performance with the performance of other local and foreign universities.

There are many factors that would affect the learning environment and the quality of the services provided by the higher educational institutions. The application of total quality management at higher education institutions is not an easy task; it consumes lots of time, money and efforts. The total quality management would require the institution to be fully committed to a continuous cycle of improvement and development.

As per Tarawnwh and Mubaslat (2011) applying the concepts, principles and tools of TQM at higher education institutions face many problems/ obstacles such as the following:

- The difficulty of determining the quality of non-tangible educational services in higher education institutions.

- Most of the higher education institutions focus on introducing and applying several laws and standards to develop the educational system; however, little work is done to measure and control the quality of their system.

- Limited budget and resources

the institution or government can afford which leads to the decrement in the performance of the institutions and the decrement in the quality level of its outputs.

Some studies, such as Rosa *et al.* (2012) study, have agreed on the non-applicability of the TQM practices in HEI's claiming that the difficulty comprises from the fact that the higher education is a service which is intangible. On the other hand, many other studies were against this idea and have highly supported the idea of implementing TQM practices on the HEI's such as Al-Tarawneh and Mubaslat (2011) and Abou Chahine *et al.* (2008). Salameh *et al.* (2011) stated in their research

that the traditional administrative methods are no longer useful for higher education institutions and it should be replaced by the TQM philosophy to improve the performance of the HEI's. The reason behind the ineffectiveness of the traditional methods stems from environmental forces such as growing number of students, competition between higher educational institutions and the flexibility of programs in both postgraduate and undergraduate levels which certainly have made the need for effective implementation of quality in higher education more essential (Najafabadi *et al.* 2008).

As Abou Chahine *et al.* (2008) have showed, the effectiveness of the educational quality would first depend on the proper identification of the clients of the HEI's. Hereby, there are two primary clients: students and other stakeholders such as parents/ guidance, business, society, etc; where students are performing a dual role: the role of the client, and the role of the product of higher education. Salameh *et al.* (2011) have declared that the student satisfaction is the crucial factor in the success of the higher education and it must be the focal point in all TQM practices.

The main objective of this research is to show the importance of assessing and continuously improving the performance of the higher educational institutions by applying several qualitative and quantitative TQM tools, and this will allow determining the areas of potential improvement and obstacles that it might face (Tarawneh and Mubaslat, 2001).

2. Overview of QFD

A large number of TQM tools are applied in different manufacturing and service disciplines to improve quality. One of the most common approaches for assessing quality in higher education institutions is the Quality Function Deployment (QFD). The QFD, which was first developed by Dr. Yoji Akoa in the 1960's, is a quantitative tool that translates a set of customer requirements into operation requirements to be met by a new product and process design. The QFD is applied by using a sort of matrix called the House of Quality (HOQ)

2.1. House of Quality

According to Mukaddes *et al.* (2010), "Quality Function Deployment helps to maintain a correct focus on true requirements and minimizes
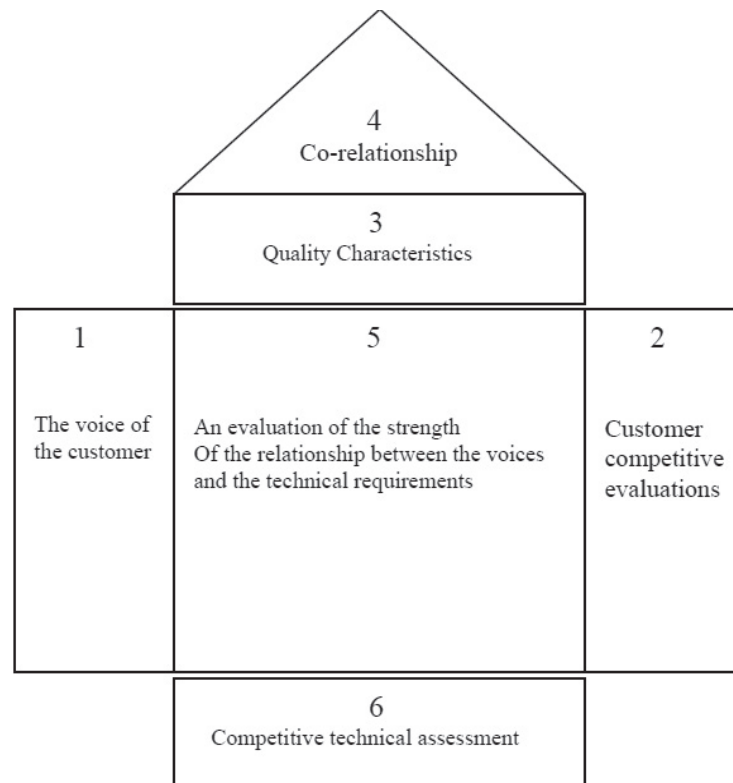
Figure 1. House of Quality.

misinterpreting customer needs". Thus, this matrix allows organizations to prioritize the customer requirements, identify their position within the market, and identify their position against other competitors (benchmarking). Moreover, Shyamal (2011) has stated that relating customer requirements to technical requirements through the QFD support the idea of work team between design engineers, marketing staff, and manufacturing workers. QFD also support the concept of continuous improvement since organizations are continually required to research and develop in accordance with the changes in customers' needs and the rapid technological changes. As per Qureshei *et al.,* 2012, applying QFD in higher education institutions has hereby recorded a remarkable success since it is capable of maintaining a customer oriented service.

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3. Methodology

The QFD has been used as a tool of quality assessment and improvement for the Faculty of Engineering at AlHosn University and as a tool of benchmarking for some of the higher education institutions in the city of Abu Dhabi. The QFD
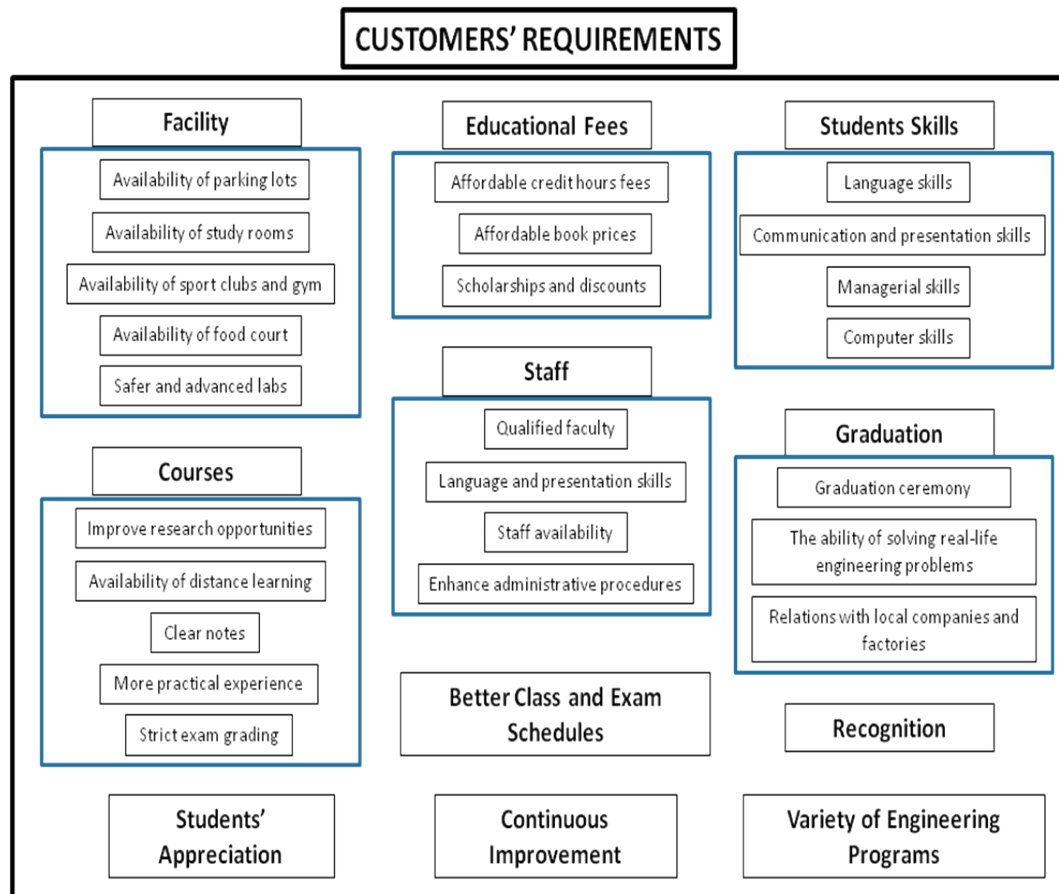
Figure 2. Affinity Diagram for Customers' Requirements.

was applied by constructing the House of Quality matrix through the following steps:

3.1. Step 1: Identification of the customers' requirements

The quality function deployment process starts by identifying the needs and requirements of customers, or what is called the voice of customer, which is certainly considered as the most important step through the QFD process Qureshei *et al.,* 2014. As it has been mentioned before, any higher educational institution would have two basic types of customers: the students and the market. Hereby, students were encouraged to describe their needs in their own words by having two focus group sessions with both male and female students from the engineering college at ALHOSN University.

3.1.1. Affinity and Tree Diagrams

The students' and market's requirements were entered into the customer requirements portion in the House of Quality matrix after constructing an Affinity Diagrams as shown in Figure 2.

The affinity diagram previously shown is one of the Total Quality Management tools that is aimed to summarize the large number of ideas and issues created at the focus group sessions. According to Breyfogle (2003) the affinity diagrams helps individuals in better understanding the essence of the problems and breakthrough solution alternatives. The requirements were then entered into a Tree Diagram Figure 3, which is used "to communicate a logical relationship that is hierarchal between events" (Breyfogle, 2003:124). Such diagram made requirements easily arranged to be directly entered into the House of Quality.
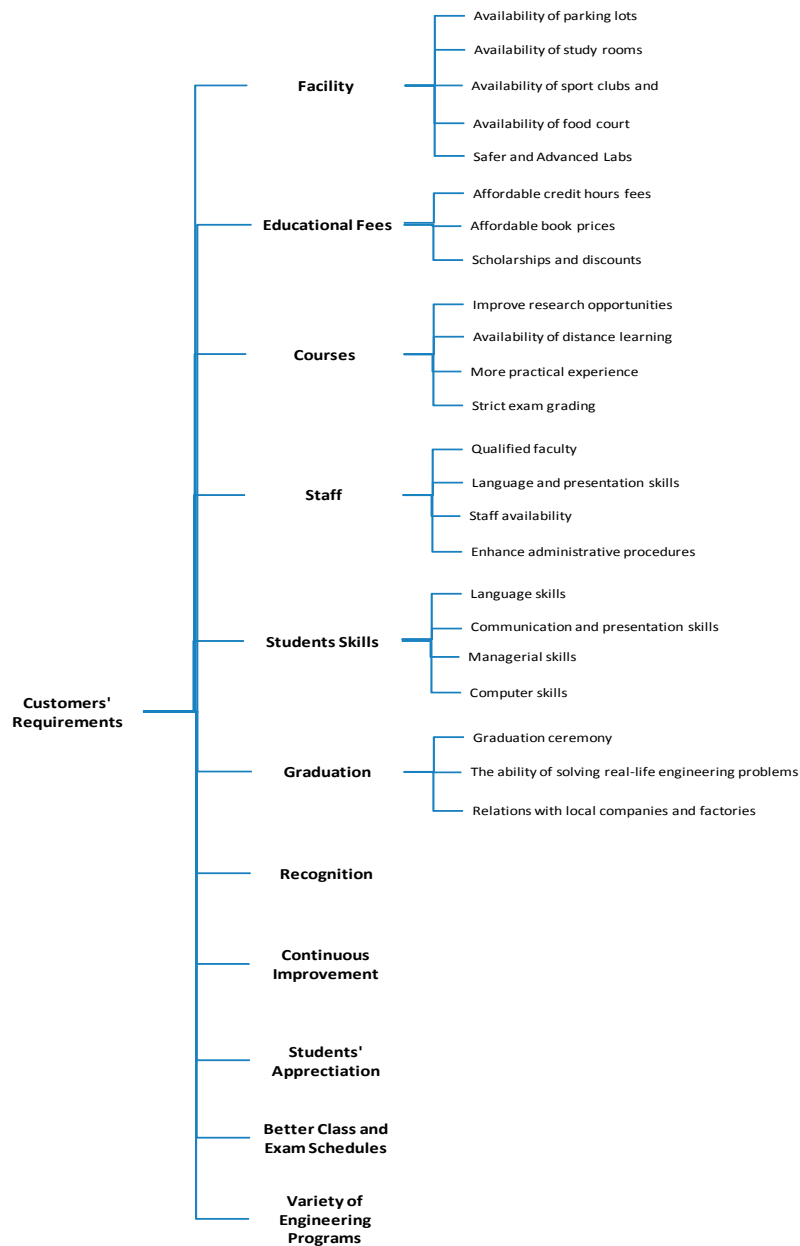
Figure 3. Customers' Requirements Tree Diagram.

3.2. Step 2: Identification of the technical requirements.

This step deals with the technical specifications that ALHOSN staff and employees would require through the educational process at the university. At this step, a meeting with academic and administrative staff from ALHOSN University was held in order to clarify how customer requirements can be achieved; or what is called the voice of engineering. Identifying the technical requirements would certainly describe the quality of the university's products who are the students. Following are the technical requirements.

Table 1. Technical Requirements.

Faculty skills	Examination skills
	Communication skills
	Lecturing skills
Students' skills	Hard-working students
	Active research
Students: teaching staff ratio	Sufficient number of teaching staff
	Appropriate size of class
Facilities	Strong library
	Sport activities for students
	Engineering equipments for labs
	Bigger campus
	Good environment for teaching
Students' evaluation	Entry exam
	Exit exam
Faculty's evaluation	Faculty selection criteria for recruitment
	Evaluation for courses
Encourage students to read	-
Educational field trips	-
Internship	-
Time flexibility for faculty	-
Decrease the work-load on faculty	-
Financial incentives	-
Online procedures	-

3.3. Step 3: Quantifying the relative importance of each of the customer requirements.

At this step, the house of quality deals with finding out the relative importance of each of the customer requirements.

This has been done through distributing a survey that has a scale from 1 to 5 where 1 represents an extremely unimportant requirement and 5 represent an extremely important requirement. The survey was distributed among customers –female students and male students from ALHOSN engineering college and 95 surveys were collected back. According to the results of the surveys, an average importance value was calculated for each of the requirements.

3.4. Step 4: Performing benchmarking assessment of the customer requirements

This step performs a benchmarking assessment between ALHOSN University and two of their competitors within the city of Abu Dhabi; they would be named as Competitor 1 and Competitor 2. Hereby, we have distributed another survey to determine the satisfaction level of students of each of ALHOSN, Competitor 1, and Competitor 2 regarding each if the requirements mentioned at step 1. Another time an average value for each of the satisfaction weightings for each of the three universities has been calculated as shown in Figure 4.

3.5. Step 5: Relating the students' requirements with the technical requirements

This step forms the inside of the House of Quality and used to detect the relationship between the customers' needs and the staff requirements. These correlations are determined QFD team and represented using one of the three following symbols:

⬤	+ 9	Strong
▲	+ 3	Medium
◯	+ 1	Week

3.6. Step 6: Identification of the interrelationship among the technical requirements.

This step is responsible for building the roof of the House of Quality, the roof which is also called the correlation matrix is used to examine the interrelationships between the technical requirements. The interrelationships usually determined by the QFD team and expressed by variety of symbols such as:

⊕	Represents a positive relationship
⊖	Represents a negative relationship

3.7. Step 7: Calculations of the planning matrix

Here, the students' requirements planned satisfaction rate and sales point were set in order to calculate the improvement factor and the overall weighting of each of the requirements.

In case of the planned satisfaction rate it was indicated in accordance with the university's current capabilities in providing students with the requirements they need. The rates used at this step are the same as those used in step 3. Then, the sales point were determined based on the importance weighting of the requirement where each requirement was given a point within the range of 1 to 1.5 in such a way that high sales points are given to requirements which have high importance weighting. Sales values are used to add weight to the requirement where it can be utilized by the university to promote the programs and accordingly attract more students to the university.

The improvement factor was then calculated using the following formula:

$$IF=([PSR–SW]\times II)+… … …eq. \qquad (1)$$

Where:

- IF: Improvement Factor
- PSR: Planned Satisfaction Rate
- SW: Satisfaction Weighting of ALHOSN University students
- II: Improvement Increment, which had a fixed value of 0.2

Lastly, the overall weighting represented in the last column of the house of quality was calculated by multiplying the importance weighting by the sales point and the improvement factor.

3.8. Step 8: Prioritizing the technical requirements in meeting the customers' expectations

This is the final section of the HOQ matrix and it sum up the conclusion drawn from the data contained in the entire matrix. This section is often made up of three essential parts: the target value, absolute weight and the relative weight.

- Target Value – is an objective measure that defines by how much each technical requirement should be improve in order to meet or exceed the customer's expectation. The target value should not be determined in vain, the QDF team should fully understand the customer needs, the competitor's performance and the organization's current performance before determining any of the target values.

The last two rows of the HOQ matrix are the absolute weight and the relative weight. Those weights show the impact of technical requirements on the customer requirements. The formulas used to calculate each of these weights are as follows:

- Absolute weight

$$a_j = \sum_{i=j}^{n} R_{ij} C_i \ldots \ldots \ldots eq. \qquad (2)$$

Where:

a_j: row vector of absolute weights for the technical requirements (j=1, 2, …, m)

R_{ij}: weights assigned to the relationship matrix (i=1, 2, …, n), (j=1, 2, …, m)

C_i: column vector of importance weighting (i=1, 2, …, n)

m: number of technical requirements

n: number of customers requirements

- Relative weight

$$b_j = \sum_{i=j}^{n} R_{ij} d_i \ldots \ldots \ldots eq. \qquad (3)$$

Where:

b_j: row vector of relative weights for the technical requirements (j=1, 2, …, m)

d_i: column vector of overall weighting for the customer requirements (i=1, 2, …, n), (j=1, 2, …, m)

Higher absolute and relative weights indicate the critical areas where the engineering efforts need to be concentrated.

The results of applying QFD at the college of engineering at ALHOSN would be discussed in the following chapter: Results and Discussion.

4. Results of applying Quality Function Deployment at ALHOSN University

The QFD has been used in identifying the characteristics that needs to be enhanced in order to meet customers' expectations. As shown in Figure 4, the customers' requirements were identified and had

included requirements regarding the offered courses, facilities, educational fees, and others. Similarly, the technical requirements (staff requirements) were identified and had included requirements such as students' evaluation, faculty evaluation, etc.

According to the survey done at step 3, it was observed that all of the requirements mentioned in Figure 4 have got a high rank by students; a rank of 4 (important) and a rank of 3 (neutral). But regarding the satisfaction weighting of Alhosn students which was done at step 4, it was shown that most of the requirements has got a rank of 2 (unsatisfied) and 3 except one of the requirements that got a rank of 4 (satisfied); satisfaction with the qualifications the faculty have. By comparing the satisfaction weightings of Alhosn University with the competitor universities it was noticed that Alhosn satisfaction weightings were either behind the satisfaction weightings of the competitors or similar to those of the competitors except that Alhosn has got a higher rank in satisfying students with their qualified faculty than Competitor 1 has (rank of 3) and a similar rank to Competitor 2 (rank of 4).

The relationship matrix between customer and technical requirements done at step 5 shows that all students' requirements regarding the facility has a strong relationship with possessing a bigger campus. It also shows that students who are hard-working and actively research are the students' who get appreciated. Another observation is that active research cannot be done unless students' were provided with advanced and safe labs, appropriate language skills courses to write research papers, etc. Moreover, making relations with local companies and factories is strongly associated with the educational field trips and internships done by university. The House of Quality (HOQ) provided in Figure 4 shows other relationships between both types of requirements.

The roof of the house of quality (step 6) has shown the interrelation of the technical requirements. It has shown that the results of the students' exit exam are strongly associated with students' internships and educational field trips. Also, it shows that the provision of abigger campus would allow staff to have the appropriate number of students in class, provide students with sport activities, and possess a larger and stronger library which would certainly lead to a better learning and teaching environment. Other relationships can be seen in the HOQ in Figure 4.

Figure 4. House of Quality.

At step 7, it can be seen that many of the customers' requirements planned satisfaction rate is much higher than the current satisfaction weighting of Alhosn students. For instance, the requirements of advanced labs, practical experience, relations with local companies and factories have a satisfaction weighting of 3 while the planned satisfaction rate is 5. Also, the column of the sales point has included high sales point which the university must use in marketing the engineering programs at Alhosn such as the qualified faculty which was given a sales point of 5. Lastly, the overall weighting was calculated to find out that the ability of solving real life engineering problems, the relations with local companies and factories, the recognition and the continuous improvement have got the highest overall weighting value. On the other hand, the availability of distance learning has got the least overall weighting value which was 3.75.

Lastly, the target value was set and the absolute and relative values were calculated in the last three rows in the house of quality. It is worth mentioning that the higher the absolute and the relative values of the requirements are, the more technical efforts are needed in those areas. In this case study, the requirement of having a bigger campus has got the highest absolute value which is 315, and the highest relative value which is 500.1.

5.   Discussion

The study has revealed that there is a good awareness from top management of the importance of applying quality practices at their higher education institution. In this regard, the university has given the quality of the programs a great attention through implementing quality standards imposed by the ministry of education and the ABET. They also implement some of the quality practices in order to assure the continuous development and the customers' satisfaction such as distributing surveys and getting the feedback so they can develop action plans to follow.

One of the TQM practices that the university must consider is benchmarking in order for the university to be one of the best competent among local and hopefully foreign universities. At this study, benchmarking has been performed through the utilization of the Quality Function Deployment matrix and it was seen that the university is still behind other competitors at some places. Also, the study has shown that there is a general feeling that the students are not satisfied with the services they are getting; This was concluded from the application of the QFD tool where satisfaction weighting have smaller values than the importance weighting indicating the university must give the student's requirements more focus.

6.   Conclusion

Total quality management (TQM) is an integrated organizational effort designed to improve quality at every level to achieve excellence. TQM has a remarkable application in HEI's where the adaption of TQM will help the higher educational institution to maintain their competitive position, satisfy all stakeholders, focus on the market needs and achieve higher performance. There are varieties of qualitative and quantitative tools and techniques that can be used in order to implement TQM principles such as benchmarking, statistical process control, quality function deployment, failure mode and effect analysis, Pareto charts, cause and effect diagram and others.

7.   Recommendations

There is a need for big change in higher education institution quality management style. TQM must hereby be used as a quality system to be followed in any institution in order to make development. Academic and administrative staff should be provided with Total Quality Management training courses to assure TQM's success in higher education institutions. In this regard, financial resources must be properly allocated for training staff.

The staff should be provided with the necessary skills to practice TQM tools, especially statistical control methods so that TQM practices can be monitored and controlled.

The following recommendations were proposed to be implemented in areas that need more attention to be paid: the provision of a bigger campus for students and faculty in order to have a better learning environment. There is a big need for establishment of a research center (including labs) in the university's campus in order to increase the research opportunities for both students and faculty.

Relationships with local companies and factories should be available in order to gain recognition

and provide students with the necessary practical experience. Moreover, it would increase the chance for graduated students to find jobs after graduation.

The university must have selective criteria in choosing students. Students who want to register at the university must pass an entry exam; in case of engineering college, the exam should include questions from math, chemistry, physics, and English subjects. There is also a need to have an exit exam to verify whether they possess the proper qualifications to practice real life jobs. The exam would include questions from a variety of courses the student has studied in the program.

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