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The Effect of Implementing of Six Sigma Approach in Improving the Quality of Higher Education Institutions in Bahrain

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ABSTRACT

The main important issue in education curriculum currently is best quality in higher learning. The stakeholders and the growing competitive environment has have increased the demand for higher quality. Previously, Six Sigma has successfully been applied in the product and service improvement in the field of business, but still, this concept has not yet been adopted in the higher education. This study outlined the models that can be adopted by improving the quality of higher learning by applying this concept. Applying the six sigma principles, for instance, the continuous improvement, reduction in waste, and process improvement apply closely to the accreditation agencies and the higher education institutions missions. The study used the questionnaire instrument to collect the data randomly from a sample of (357) respondents representing the general staff of higher education institutes at Kingdom of Bahrain. It has been established that majority of the institutions (56.7 per cent) use six sigma model in improving quality. They invest in communicating the quality objectives to the employees. This is important as communicating quality objectives and the modalities of attaining them are important to the institution. Study recommended ensuring that there is elaboration and well-communicated quality policy, and it is essential to be known by all stakeholders.

Keywords-- Six Sigma, Higher Education Institutes, Business Improvement, Quality, Lean

I. INTRODUCTION

At present, there is no doubt that one of the key aspects for the development of the people is their education. Development of education is related to the concept of quality in education. However, the concept of quality in education seems to be elusive and the scholars on the subject have defined it with different view of point. One definition of quality in education by the authors [1]–[3] stated that the quality in education "focusing on meeting a pre-defined set of standards, specifications, and requirements, or focusing on exceeding the highest standards in pursuit of excellence and exclusivity". Other definition by the authors [4], [5] stated the quality in education can be defined as "focusing on accountability to the public or providing a transformative learning experience to benefit students and employers".

The quality of education is necessary in worldwide institutions due to its positive effects on educational process, provide the ability to teachers to transmit the knowledge for learner in a best way, provide development strategies for teachers and learner and ensure of best content of educational knowledge. The Six Sigma can be defined as the process that improves the quality by data gathering, creating understanding and taking into control the probable variations to improve predictability in school and business institutions. It defines measures, analyzes, improves, and controls (DMAIC) process. These aspects act as the key roles for the Six Sigma. It strongly emphasis on the values so that it can project on high returns to gain the best benefits. It creates a supportive internal change that begins with support from the administrations.

In the higher education set up, adapting this approach require in-depth scrutiny of the requirements and expectations of stakeholders. We can perceive higher education unlike in a business platform in the aspect of non-profit making services concerning intellectuality and societal needs. For example, in the educational setup, data is underestimated since education is not always data driven. On the other hand, the business process analyzes from the academic world. To improve the processes in a business, we need to analyze business process reengineering (BPR), Total quality management (TQM), Six Sigma, and Lean Manufacturing. TQM plays a better role in the departmental processes affecting the transition; Lean Six Sigma creates few but highly effective to departmental improvements [6], [7]. Form [8] study, Lean Six Sigma data collection take too long and therefore needs to be reduced to complete the process. Since the enrollment in the campus for most of the students is only four years, this cannot work creating the need to mix the most appropriate level of Lean Manufacturing and Six Sigma to make this process more relatively short especially in data collection on the individuals. This method, therefore, applies the aspect of the statistical tools to create moderately complex short time that focuses on eliminating waste.

Higher education process matches perfectly with manufacturing process in which raw materials pass through

a series of steps to produce finished goods. This is similar to and higher education graduates passed through a series of steps. Quality is dependent on various factors which include course content, incoming students, teachers, curriculum, assessment methodology, and pedagogy. Therefore, since the bigger role for Lean Manufacturing is to eliminate waste in educational setup (waste includes duplicated topics, spoon feeding, redundant introduction, etc.), it must be undertaken throughout the process to have the best graduate. Through the use of Six-Sigma in business, variations and waste can be eliminated or at least minimized. Because of the clear flow charts which define each and every procedure and the way every activity needs to be done, we are able to focus only on what is considered important for the processes of the business. This will ensure that the business does not spend resources on the issues and matters that do not add value to the business processes. We are also, through the use of Six-Sigma in business, able to reduce defects. This is because employees are able to identify problem areas and issues that are recurring and which can compromise the overall quality expectation of a product or service from the viewpoint of the customer. Once identified, the needs can be addressed in a timely manner and thus save the organization any associated wastes. This would ensure that the customer is highly satisfied. Six-Sigma thus ensures that the business has in place customer-oriented approach to the production processes of products and services.

Six-Sigma also provides the organization with a room for improvement because employees who are duly trained in the Six-Sigma processes are equipped with the necessary skills as well as tools which would enable them identify bottlenecks that can camp down performance. The skills on Six-Sigma enable them to identify improvement areas and thus work continuously toward it. The final result is that through the Six-Sigma skills the business can realize improvement in the existing services as well as products and thus assist with how to develop new and high-quality product for the business.

The world is evolving at a time when most higher learning instructions are relying on the aspects of specialization, internationalization, learning and bonding with companies with a goal for excellenc2e. These rapid revolutions on tools, technologies, and regulation impose on the challenge of quality education in higher institutions. The need to improve the quality of education will affect students, employers, teachers, managers and all the components of the higher education. There is a need for the institutions to innovate supportive tools that will enhance chances of improving processes quality, especially on the important fields particularly research, services, and teaching [9]. Once these levels are effectively put in place, the mode of delivery service will improve hence higher chance of motivating students to join their institutions. They will achieve success if they can offer what is exceptional from other institutions. Previously, Six Sigma has successfully been applied in the product and service improvement in the field of business, but still, this concept is yet to be adopted in the higher education.

Therefore, the first phase is defining step, which is aimed to formulate related parameters of the Six Sigma by understanding the process and know the overall map to implement the strategies at the educational institute. Second, is to measure the process in terms of numbers. Third, is to analyses the how the process map is developed based on goals to get accurate information of the issues related to educational quality. Fourth, is the improvement step, which aims to identify the weak or failure points with providing the solution in order to decrees the defects at the process way. Last phase is the control, which aims to require the HEI for more improvement according to the results obtained from the Six Sigma analysis.

In higher learning, quality assurance systems will include all the activities that will offer quality services to satisfy the minimal needs of all the beneficiaries of higher education through confidence assurance.

Based on previous clarification of statement of research problem, the research aims to answer these questions:

1. What is the degree of implementation of six sigma practices among HEIs in Bahrain in terms of DMAIC Approach?
2. Does the implementation of Six Sigma result in to a significant change in overall quality of HEIs in Bahrain?
3. What is the impact of implementing of Six Sigma in improving quality of higher education institutions?
4. What is the impact of implementing Six Sigma approach on employee's performance?

II. METHODOLOGY

This study settled for a quantitative approach with an in-depth investigation on the issue on 'the effect of Implementing of Six Sigma approach in improving the quality of Higher Education Institutions in Bahrain'. A primary research philosophy in this study would be based on an exploratory study that meets the needs of any investigation. The researcher in this study also decided to use a quantitative model and a designed experiment. In this model, the researcher sought to collaborate effectively with participants to find out the effects of Six Sigma in improving processes in higher education. Other than the two proposed methods, this study also chose to incorporate a case study from an institution to be an example of how the vast applications of Six Sigma have enhanced performance in higher education. This collaborative study will also use

the Six Sigma DMAIC principles (Define-Measure-Analyze-Improve-Control) methodology to show how processes can be improved at Bahrain Universities. In the define phase, the researcher will;

1. Develop a problem statement that would help increase understanding of any gaps in the process
2. Create a project charter that would help reach an agreement with reference to project goals
3. Perform a stakeholder analysis in identification of which stakeholders are impacted by the project and the process.

To show the effects of Six Sigma methodology in higher institutions, this researcher will use the SIPOC (Suppliers-Inputs-Process-Outputs-Customers) tool to gain an understanding of the five to seven activities that are improved. The design phase of the study will have a project manager who will develop a project plan with a purpose of guiding the project to success. The measure phase will rely on subject matter experts in order to observe any operational processes and create process maps. The researcher will create a plan for data collection to identify what data is necessary and the metrics to help understand the current process. Understanding the needs of consumers related to every process will be essential to identify the critical needs for satisfaction. The researcher will also use graphical, inferential and descriptive statistics to understand the factors and processes that affect institutions. The analyze phase will identify root causes and factors that contribute to problems in the process by using a why-why analysis. As part of the analysis, the researcher will design recommendations that can be used to improve implementation process. The control phase will design control plans and implement any other process improvements.

Data gathering made possible through a quantitative research and the use of surveys and questionnaires. Quantitative research is the systematic and empirical investigation of a social phenomenon through numerical, mathematical, statistical and computational techniques. According to [10], the purpose of a quantitative research is to develop mathematical theories, model and hypothesis that relate to the phenomenon under study. The researcher expects that the data collected from the questionnaire would target institutions of higher learning across the world to show them how to create significant practices internally and deliver effectively to their audience. The aim of the questionnaire according to [11] is to help discover a causal link between variables and the sample population. The population of participants will be identified to be university stakeholders ranging from students, instructors, staff and parents and a random sample taken using less complicated sampling techniques where participants will be asked about the effectiveness of Six Sigma. Sampling will be done using non-probability sampling technique. Because one might not find it easy to sample from a population when they do not know what they are looking for, the first step in the sampling process will be defining and identifying the population in which samples would be gotten from. A small sample size of subjects will be the justification of this study. To achieve the objectives of the study, closed ended questionnaires will be the appropriate means for primary data collection which allow researchers to gather insights from respondents directly. In experimental research, independent variables are those that can be manipulated by the researcher while dependent variables are those that are passively observed. In this study, the independent variable is the Six Sigma approach in itself while the dependent variables are the positive effects that come as a result of using the strategy. The list of questions will be developed with great care with a view to enable a smooth flow of response and to meet the objectives of the research.

III. LITERATURE REVIEWS

3.1. Concept of Quality in High Education Institutes

The concept of quality in education seems to be elusive and the scholars on the subject have defined it with different view of point. One definition of quality in education by the authors [6], [12], [13] stated that the quality in education "focusing on meeting a pre-defined set of standards, specifications, and requirements, or focusing on exceeding the highest standards in pursuit of excellence and exclusivity". Other definition by the authors [14]–[16] stated the quality in education can be defined as "focusing on accountability to the public or providing a transformative learning experience to benefit students and employers".

The quality of education is necessary in worldwide institutions due to its positive effects on educational process, provide the ability to teachers to transmit the knowledge for learner in a best way, provide development strategies for teachers and learner and ensure of best content of educational knowledge.

The Six Sigma can be defined as the process that improves the quality by data gathering, creating understanding and taking into control the probable variations to improve predictability in school and business institutions. It defines measures, analyzes, improves, and controls (DMAIC) process. These aspects act as the key roles for the Six Sigma. It strongly emphasis on the values so that it can project on high returns to gain the best benefits. It creates a supportive internal change that begins with support from the administrations.

3.2. Application of Six Sigma

The use of Six Sigma comes with a clear focus on achieving quantifiable and measurable financial returns to an organization's bottom line. In examining the present

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state of Six Sigma approach in service based industries, [5] prescribe ways in which organizations can actively implement the approach for positive results. Studies by [17]–[20] investigate the success factors organizations should check for while implementing Six Sigma. Other than investigating into the success factors of the approach, these authors also propose a successful framework for applying the strategy in institutions of higher learning. The main goal for Six Sigma is towards minimizing defects in the outcome of production; a defect being any factor that can cause consumer dissatisfaction. This goal is the main determinant in measuring success of an organization's operation because maximizing on customer satisfaction is what leads to an improved bottom-line performance and maintenance of a competitive advantage. The Six sigma model focuses a learning institution on understanding and managing student requirements align key institutions processes to achieve those requirements, utilize data analysis for variation purposes and drive rapid and sustainable improvement in the process of learning.

3.3. Framework for Developing Six Sigma

It cannot be doubted that more and more empirical research is needed to have a better understanding of the relevance and role of Six Sigma approach in higher education management. This approach is interested in the effect of its initiatives and at the same time works to mediate the effect of critical factors to success and limitations to change. In order to analyze these aspects systematically, this section is created with a purpose of developing a framework for conceptualizing Six Sigma development that will purify and operationalize the approach's building blocks.

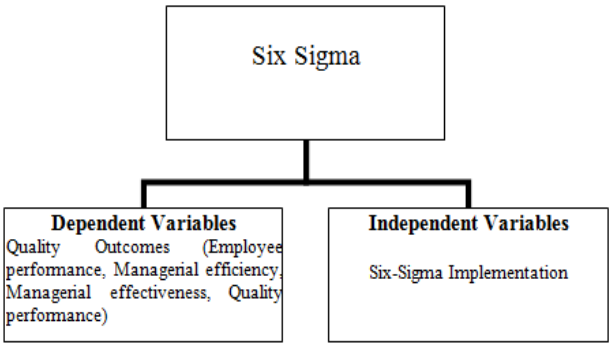

Figure 1: Conceptual Framework

The Figure.1 illustrates the independent and dependent variables of the Six Sigma research which consists of the one independent variable (Six Sigma Practices) and four of dependent variables which are (Employee performance, Managerial efficiency, Managerial effectiveness, and Quality performance) as per mentioned in the above figure.

IV. RESULTS

Table 4.5 shows the responses to the six sigma indicator dimensions. It shows that, asked about the clarity of the definition of the six sigma in the organization, the responses were agree 134 (37.5 per cent), disagree 91 (25.5 per cent), strongly agree 78 (21.8 per cent), strongly disagree 42 (11.8 per cent), and 12 (3.4 per cent) were undecided about this question.

Asked about how they think that the organization analyses poor quality processes, the responses were agreed 112 (31.4 per cent), disagreed 106 (29.7 per cent), strongly agreed 80 5 per cent). Asked about how they think that the measurement of Six Sigma is calculated in terms of numbers, the responses were agreed 112 (31.4 per cent), disagreed 121 (33.9 per cent), strongly agreed 76 (21.3 per cent), and strongly disagreed 42 (11.8 per cent).

TABLE I
RESPONSES TO DEGREE OF IMPLEMENTATION IN TERMS OF SIX SIGMA INDICATORS (DMAIC)

Aspect	Response	Count	Percent
The process of Six Sigma is clearly defined	Agree	134	37.5%
	Disagree	91	25.5%
	Strongly Agree	78	21.8%
	Strongly Disagree	42	11.8%
	Undecided	12	3.4%
The measurement of Six Sigma is calculated in terms of numbers	Agree	112	31.4%
	Disagree	106	29.7%
	Strongly Agree	80	22.4%
	Strongly Disagree	41	11.5%
	Undecided	18	5.0%
The poor quality processes of Six Sigma are analyzed	Agree	112	31.4%
	Disagree	121	33.9%
	Strongly Agree	76	21.3%
	Strongly Disagree	42	11.8%
The improvement of poor process is applied	Agree	97	27.2%
	Disagree	100	28.0%
	Strongly Agree	63	17.6%
	Strongly Disagree	44	12.3%
	Undecided	22	6.2%
The achieving quality results are standardized in form of control process	Agree	145	40.6%
	Disagree	92	25.8%
	Strongly Agree	66	18.5%
	Strongly Disagree	36	10.1%
	Undecided	18	5.0%

Asked about how they think that the improvement of poor process is applied, the responses were agreed 97 (27.2 per cent), disagreed 100 (28 per cent), strongly agreed 63 (17.6 per cent), and strongly disagreed 44 (12.3 per cent), and undecided 44 (12.3 per cent). Asked about how they think that the achieving quality results are standardized in form of control process, the responses were agreed 145 (40.6 per cent), disagreed 92 (25.8 per cent), strongly agreed 66 (18.5 per cent), and strongly disagreed 36 (10.1 per cent), and undecided 18 (5.0 per cent). As part of the World Wide Web Objects library, we have developed a Cacheable class. The class offers a small set of primitive caching operations which may be performed upon a Cacheable object, i.e., any object derived from the Cacheable class. These operations, in conjunction with

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appropriate concurrency-control, constitute the basic building blocks used by a client to explicitly specify whichever caching protocol is required. Invoking the basic operations in different sequences provides different protocols. One of these basic operations enables the proxies of Cacheable objects to obtain the state of their remote object. Client operations performed upon the proxy may then occur locally, i.e., the proxy can act as a cache.

4.1. Analysis and Findings

In order to determine the degree of implementation of Six Sigma in HEI in Bahrain, a number of aspects of Six Sigma were looked into. With respect to the clarity of definition of the Six Sigma to employees, it was established that the percentage that can be considered to be clear of the Six Sigma is 56.7 per cent. This is considered as the degree of implementation of six sigma practices through clarity of definition. Also, it is important that the quantitative aspects of the process be used as a measure of the degree implementation.

TABLE II
THE DEGREE OF IMPLEMENTATION OF SIX SIGMA PRACTICES AMONG HEIS IN BAHRAIN IN TERMS OF DMAIC APPROACH

Aspect	Percentage
HEI's with clear six-sigma explanation to employees	56.7%
HEI's that use numbers to measure six sigma outcomes.	54%
HEI's that analyze the process quality to determine sources of failure	64%
HEI's that use the information obtained to improve the process	60.7%

Here, it is established that 54 per cent of the organizations use numbers to measure six sigma outcomes. The third aspect that was probed is whether the organization analyzes the process quality to determine sources of failure. It is established that 64 per cent of the organizations do. It is further established that once such analysis is made, 60.7 per cent of the institutions use the information obtained to improve the process. It is also established that 66.7 per cent of the organizations standardize the quality results in form of control processes.

4.2 One-Sample T-Test for Comparing Overall Quality in Higher Education Institutions in Bahrain

TABLE III
ONE-SAMPLE T-TEST

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Institutions Using Six-Sigma	57.695	55	.000	4.31071	4.1610	4.4604
Institutions Not Using Six-Sigma	74.732	300	.000	4.02326	3.9173	4.1292

The Table III shows that there are about 56 out of 357 responses to the negative with respect to the use of six-sigma. This shows that there are about 84.3 percent of the Bahrain institutions which use six-sigma as one of the overall quality improvement tools. The decision to reject or not to reject the null hypothesis is bases on the significance (p-value). From the table the p-value of the mean comparator is 0.000 which is an indicator that there is a statistically significant difference in overall quality outcomes between higher education institutions in which six-sigma is implemented and the ones in which it is not. This is done at 95 percent level of significance. Since the mean overall quality outcomes for the institutions using six-sigma is higher than the mean for the ones not using, it implies that six-sigma contributes more in order to overall quality and thus should be adopted.

V. CONCLUSION

The study has explored a number of questions in the survey conducted to enable the researcher to get meaningful understanding of the research questions.

For the first indicator, it sought to establish the degree of implementation of Six Sigma practices among HEIs in Bahrain in terms of DMAIC approach. It has been established that majority of the institutions (56.7 per cent) use six sigma model in improving quality. They thus invest in communicating the quality objectives to the employees. This is important as communicating quality objectives and the modalities of attaining them are important to the institution.

The second indicator which is "Overall Significant of Six Sigma in quality of HEIs" found that six sigma model of quality has transformed a number of ways in which institutions operate. The areas include increasing efficiency in undertaking processes such as processing student marks within the shortest time possible. It is also used as a means of cutting down on costs because it helps in eliminating redundancies in processes which can lead to double expenditure if it goes uncontrolled. It is also applied in the reduction of error rates in processes. This is attributed to the fact that it can enable the users of a system to detect errors in a timely manner and come up with solutions that prevent the occurrence thereof. Six sigma model as a quality improvement is also used by these institutions to help in improving productivity.

At the third indicator, study has also developed that 60.6 per cent of the institutions of higher learning were planning an improvement program, 71.3 per cent of the institutions have experienced institution currently planning the improvement program to meet the quality's requirements, and 71.3 per cent of the institutions accept that there is continuous change in adopting the program. It is also established that 60 per cent of the institutions use Six Sigma model for quality purposes and that 66 per cent of the institutions conducts decision making strategic process to meet the best performance, and the same percentage uses Six Sigma in improving quality performance. This is an

indicator that "Impact of Six Sigma implementation in improving quality of HEI" should be invested if some desired change is to be realized. One such way of improving quality is to ensure that data is kept which can be used as evaluation and monitoring basis always.

At the fourth indicator of "Impact of Six Sigma implementation on employee's performance", it concludes that there is an acceptance of 81% that the institution making use of experiences to raise the employees' performance, and 78% of employees accepted that the Six Sigma approach developed their work environment. This indicator concludes that the Six Sigma approach has positive effect on employee's performance at HEIs at Bahrain.

Main recommendations of this study are: a) Conducting internal regular reviews at the institution based on Six Sigma indicator (DMAIC) to ensure the HEI is meets the requirements of Six Sigma approach, b) Ensure that various quality metrics are agreed and use as a basis of monitoring and evaluation of the institutional quality objectives. The metrics of interest include productivity, cost reduction, error rates, and employee variables such as motivation and attitude toward work as well as customer satisfaction and throughput time, c) Ensure that quality data are recorded, documented, and stored in a repository to ensure that they can be used easily and promptly as and when wanted. Recording, documenting, and storage of data in the repository is essential in ensuring that there is always a basis for retrieval to enhance information sharing for quality improvement purposes, d) Encourage employees to provide their suggestions that influence to improve the decision making at HEIs, and e) Ensure that there is an elaborate and well-communicated quality policy which is made known by each and every stakeholder.

This will encourage participation toward policy by stakeholders from adequate information endowment position. It is established from the research that there is a lapse in quality information sharing and thus there is need to enhance the sharing thereof.

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