

T.C.
MARMARA UNIVERSITY
INSTITUTE FOR GRADUATE STUDIES IN
PURE AND APPLIED SCIENCES

SIX SIGMA PHILOSOPHY-AN APPLIED STUDY
IN THE UNIVERSITY FOR EDUCATION SYSTEM

Sinem TUĞRAL KURULTAY

THESIS
FOR THE DEGREE OF MASTER OF SCIENCE
IN
INDUSTRIAL ENGINEERING

SUPERVISOR
Prof. Dr. S. Ümit Oktay FIRAT

İSTANBUL 2010

T.C.
MARMARA UNIVERSITY
INSTITUTE FOR GRADUATE STUDIES IN
PURE AND APPLIED SCIENCES

SIX SIGMA PHILOSOPHY-AN APPLIED STUDY IN
THE UNIVERSITY FOR EDUCATION SYSTEM

Sinem TUĞRAL KURULTAY
(141100920060125)

THESIS
FOR THE DEGREE OF MASTER OF SCIENCE
IN
INDUSTRIAL ENGINEERING

SUPERVISOR
Prof. Dr. S. Ümit Oktay FIRAT

İSTANBUL 2010

MARMARA UNIVERSITY
THE INSTITUTE FOR
GRADUATE STUDIES IN PURE AND APPLIED SCIENCES

ACCEPTANCE AND APPROVAL DOCUMENT

The jury established by the Executive Board of the *INSTITUTE FOR GRADUATE STUDIES IN PURE AND APPLIED SCIENCES* on 25/01/2010 (Resolution no: 2010/02-29) has accepted Ms Sinem TUĞRAL KURULTAY's thesis titled "**SIX SIGMA PHILOSOPHY-AN APPLIED STUDY IN THE UNIVERSITY FOR EDUCATION SYSTEM**" as Master of Science thesis in Industrial Engineering.

Advisor : Prof Dr. S.Ümit OKTAY FIRAT (Marmara University)

1. Member of the jury: Prof Dr. Selim ZAIM (Fatih University)

2. Member of the jury: Asst.Prof Dr Serdar YÖRÜK (Marmara University)

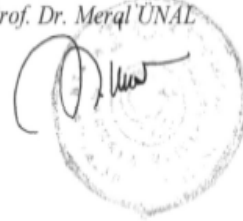
Date : 09/02/2010

APPROVAL

Mr/Ms. ~~Sinem TUĞRAL KURULTAY~~ has satisfactorily completed the requirements for the degree of Master of Science / ~~Doctor of Philosophy~~ in ~~Industrial Engineering~~ at Marmara University. The Executive Committee approves that he/she be granted the degree of Master of Science / Doctor of Philosophy on 25/01/2010 YK tarihi (Resolution no: 2010/02-29)

DIRECTOR OF THE INSTITUTE

Prof. Dr. Meriç UNAL



ACKNOWLEDGEMENTS

I would like to thank Prof. Dr. S. Ümit OKTAY FIRAT for her valuable support and her continuous help in making everything clear during my thesis work.

I would also like to extend my thanks to Dean of Marmara University Engineering Faculty Prof. Dr. Abdülkerim KAR. I also need to thank Prof Dr. Ercan ÖZTEMEL and Asst. Prof. Dr. S.Serdar YÖRÜK who study in Strategic Planning Process for their help to orient me towards to this thesis topic.

In my last sentences, I would like to thank my husband A. Alper KURULTAY for his support and help. Alper has been always up when I was down, with his courage and love during these two years and will be with me to the end of my life.

Needless to mention, all the members of my family deserve great appreciation for their support, patience and understanding throughout my educational life.

February, 2010

Sinem TUĞRAL KURULTAY

TABLE OF CONTENTS

ÖZET	iv
ABSTRACT	v
ABBREVIATIONS	vi
LIST OF FIGURES	vii
LIST OF TABLES	viii
PART I. INTRODUCTION AND OBJECTIVE	1
PART II. GENERAL BACKGROUND	3
II.1. GENERAL PROFILE	3
II.2. HISTORY OF MARMARA UNIVERSITY	5
II.3. LITERATURE REVIEW	6
II.3.1 Six Sigma Literature Review	6
II.3.2 Qualitative Analysis Literature Review	15
II.4. RESEARCH METHODOLOGY	16
PART III. QUALITATIVE RESEARCH	18
III.1. DEFINING QUALITATIVE RESEARCH	18
III.1.1 The Basics of Qualitative Research.....	19
III.1.2 The Historical Development of Qualitative Research.....	19
III.1.3 The Applications of Qualitative Methods to Social Research....	20
III.1.4 The Functions of Different Qualitative Methods	20
III.1.5 Methods of Analysis.....	21
III.2. QUALITATIVE RESEARCH TECHNIQUES	22
III.2.1 Case Studies.....	24
III.2.2 Etnographies	25
III.2.3 Phenomenological Studies.....	26
III.2.4 Grounded Theory Studies.....	26

ÖZET

ALTI SİGMA FELSEFESİ – ÜNİVERSİTEDEKİ EĞİTİM SİSTEMİ İÇİN BİR UYGULAMA ÇALIŞMASI

Altı Sigma yöntemi incelendiğinde, hizmet sektöründe ve özellikle eğitim alanında uygulanması zor bir yöntemdir. Bu çalışmada “Kalitatif Analiz” Metodu kullanılmıştır. Mevcut süreçler bu metotla belirlenmiş ve süreçlerin Altı Sigma yöntemiyle iyileştirilmesi amaçlanmıştır.

Bu tez çalışmasında “Altı Sigma Metodu ve Kalitatif Analiz yöntemi” birlikte incelenmiştir. İlk olarak Altı Sigma ve Kalitatif Analiz yöntemleri hakkında detaylı açıklamalar yapılmıştır. Daha sonra Altı Sigma’nın TÖAİK(Tanımlama-Ölçme-Analiz-Iyileştirme-Kontrol) metodu tanımlanmıştır. Tanımlama ve Ölçüm bölümlerinde Kalitatif Analiz yöntemi kullanılarak Marmara Üniversitesi Endüstri Mühendisliği bölümü yöneticileri ve akademik kadrosu ile bire bir karşılıklı görüşmeler yapılmıştır. Bu görüşmeler ile mevcut süreçler tanımlanıp değerlendirilmiş ve analiz edilmeye çalışılmıştır.

İyileştirme kısmında sorunlu süreçlere çeşitli çözüm yolları önerilmiştir. Kontrol kısmında uygulanan çözümler için ölçme ve değerlendirmede gerekli olan veriler tanımlanmıştır.

Şubat , 2010

Sinem TUĞRAL KURULTAY

ABSTRACT

SIX SIGMA PHILOSOPHY- AN APPLIED STUDY IN THE UNIVERSITY FOR EDUCATION SYSTEM

The Six Sigma Method is a difficult method when it is applied in service sector, especially in education organizations. The Qualitative Analysis Methodology was primarily used while making this study. Current processes were determined with this method and improvements of processes were aimed by applying Six Sigma.

In this study, the Six Sigma was researched with Qualitative Analysis Methodology. Initially, detailed explanations of “Six Sigma and Qualitative Analysis” methods were given. Then, the DMAIC Methodology, an aspect of Six Sigma, was defined. Academic staff and directors of the Marmara University Industrial Engineering Department, both faculty members and research assistants, were interviewed in Define and Measure Phases by using Qualitative Analysis Methodology. Attempts to Define, Measure and Analyze current processes were conducted via the interview process.

Various solutions were suggested for problematic processes in Improve Phase. In Control Phase, applied solutions have been defined for required data to measure and to assess.

February, 2010

Sinem TUĞRAL KURULTAY

ABBREVIATIONS

ABET	: American Board of Engineering and Technology
B.Sc	: Bachelor of Science
CCR	: Critical Customer Requirements
CSF	: Critical Success Factors
CTQ	: Critical to Quality
DMADV	: Define-Measure-Analyze-Design-Verify
DMAIC	: Define-Measure-Analyze-Improve-Control
DPMO	: Defects Per Million Opportunities
DPU	: Defects Per Unit
EFMD	: European Foundation for Management Development
EQUIS	: European Quality Improvement System
EUA	: European University Association
GE	: General Electric
GPA	: Grade Point Average
GT	: Grounded Theory
IE	: Industrial Engineering
IED of MU	: Industrial Engineering Department of Marmara University
KPI	: Key Performance Indicator
MIS	: Management Information Systems
M.Sc	: Master of Science
MUFE	: Marmara University Faculty of Engineering
Ph.D.	: Philosophy of Doctorate
R&D	: Research and Development
SIPOC	: Suppliers, Input, Process, Outputs and Customers
SWOT	: Strengths, Weaknesses, Opportunities and Threats
TQM	: Total Quality Management

LIST OF FIGURES

	<u>PAGE</u>
Figure II.1 Marmara University Faculty of Engineering.....	5
Figure IV.1 Lean and Six Sigma.....	28
Figure IV.2 Impact of Quality Level on Cost	33
Figure IV.3 Five Steps of the Six Sigma (DMAIC)	35
Figure IV.4 Systems Thinking Concept.....	36
Figure IV.5 Education System Model	38
Figure IV.6 The DMAIC Methodology	39
Figure IV.7 Process Flow Chart for Applied Study.....	41
Figure IV.8 Research Process Flow Chart.....	44
Figure IV.9 Generic SIPOC Diagram.....	45
Figure IV.10 SIPOC Diagram of an Education Process	46
Figure IV.11 Qualitative Analysis Methodology Flow Chart	49
Figure IV.12 Kano Model.....	55
Figure IV.13 Quality Management Process in Library.....	81

LIST OF TABLES

	<u>PAGE</u>
Table II.1 Program List.....	3
Table II.2 Brief Summary of the Six Sigma Literature	8
Table II.3 Literature Summary for Properties of Six Sigma.....	14
Table II.4 Literature Summary for the Qualitative Analysis Characteristics	15
Table II.5 Literature Summary of Qualitative Analysis Methodology Techniques	16
Table III.1 Traditions of Qualitative Research	23
Table IV.1 Six Sigma Levels	34
Table IV.2 Six Sigma Steps Summary.....	37
Table IV.3 SIPOC Model with Definitions.....	46
Table IV.4 Important Education CTQs	47
Table IV.5 Profile of the Interviews	51
Table IV.6 The Taxonomy of Processes in Education.....	53
Table IV.7 Important Education Processes	58
Table IV.8 Library Survey Questionnaires at Charles Sturt University	59
Table IV.9 Goals-1 about Library as Place	66
Table IV.10 Goals-2 about Library as Place	66
Table IV.11 Goals-3 about Library as Place	66
Table IV.12 Goals-4 about Library as Place	67
Table IV.13 Goals-1 about Teaching	67
Table IV.14 Goals-2 about Teaching	67
Table IV.15 Goals-3 about Teaching	68
Table IV.16 Goals-1 about Information and Access.....	68
Table IV.17 Goals-2 about Information and Access.....	68
Table IV.18 Goals-3 about Information and Access.....	69
Table IV.19 Goals-4 about Information and Access.....	69
Table IV.20 Goals-1 about Technology	69
Table IV.21 Goals-2 about Technology	70
Table IV.22 Goals-3 about Technology	70

Table IV.23 Goals-4 about Technology	70
Table IV.24 Goals-1 about Marketing	71
Table IV.25 Goals-2 about Marketing	71
Table IV.26 Goals-3 about Marketing	71
Table IV.27 Goals-4 about Marketing	72
Table IV.28 Goals-1 about Fund Raising	72
Table IV.29 Goals-2 about Fund Raising	72
Table IV.30 Goals-3 about Fund Raising	73
Table IV.31 Goals-4 about Fund Raising	73
Table IV.32 Organisation and Structure	74
Table IV.33 Space and Facilities.....	75
Table IV.34 Services	75
Table IV.35 Comparison of Literature on Developing Library Services.....	76
Table IV.36 Important Education KPIs Determined from the Interviews	77
Table IV.37 Important Education KPIs in Literature.....	77
Table IV.38 SWOT	84
Table IV.39 Collective Data for Control Phase	87

PART I

INTRODUCTION AND OBJECTIVES

The purpose of this thesis is to explore the fundamentals of Six Sigma and its use in education system. Six Sigma is a set of methodologies used by businesses to achieve extremely low failure rates in any process. Similarly, it can be used to achieve overall excellence in the field of education. Six Sigma is a unified approach to process excellence. The strategy that has to be applied in today's educational field is improving the overall performance of the students.

This study explains Six Sigma and its connection to education in an effort to provide a greater understanding of the subject. The basic driving factor, which propels the research of this topic, is the education system at the Industrial Engineering Department of Marmara University.

In this study, the clients are the students and the quality of learning they achieve is the service. It can also be said that a student is the "product", which education institutions "sell" to the future employer.

Initially, the meaning of Six Sigma was outlined, and then application of Six Sigma was proposed in the educational field in order to participate in today's competitive world. Secondly, Qualitative Research Methodology was defined and later on an applied study in faculty was proposed. Finally, this study was concluded with results and discussion.

Through a short literature survey about Qualitative Analysis Methodology and Six Sigma concepts, it has been observed that most of the applications of these concepts were about production area. In this study, the educational system was considered a service field and the Six Sigma concept was applied to the education system of MUFE. This applied study was considered to add a new challenge to the implementation of the Six Sigma concept in the service field and education system.

Initially, the literature survey was performed for Six Sigma Method. Current academic papers were investigated through online databases and libraries to obtain the present research and academic studies which are related to the main topic.

DMAIC Process of Six Sigma Method was utilized for this applied study. In Define and Measure Phases processes were evaluated by using Qualitative Analysis Methodology. Dean, Faculty Members and Research Assistants were interviewed to understand educational processes. The processes that require to be improved were defined with this Methodology.

In Analysis Phase, 'Must-Be' requirements, One-Dimensional requirements and Attractive requirements have been evaluated by using Kano Model based on the results of the interviews in Define and Measure Phases. Based on the Kano Model application, second meetings were planned. At the end of second meetings with faculty members, results were obtained for the development and improvement of education processes in MUFE. The results enabled the study to propose solutions for complete education process. In Control Phase, the necessary data collection has been outlined in accordance with the generated solutions in Improve Phase.

Finally, Six Sigma Method and Qualitative Analysis Methodology were used together with this applied study. It has been observed that Six Sigma could be used in education system.

PART II

GENERAL BACKGROUND

In this study general information about Six Sigma and Qualitative Analysis Methodology has been given. In addition, detailed discussions have been carried out with faculty members by using Qualitative Analysis Methodology. First of all, the education process of MUFE (Marmara University Faculty of Engineering) was examined in detail.

II.1. GENERAL PROFILE

Marmara University Engineering Faculty was established in 1987 and after three years of study, undergraduate education commenced. Since the 2005-2006 academic years, the large amount of students, faculty members and administrative personnel have made Marmara University one of the largest universities in Turkey. Most of the university is located on the Anatolian side of Istanbul, and is composed of 13 faculties, 9 vocational schools of higher education, 11 institutes, and 31 research centers. Additionally, the university is situated in 13 different locations in Istanbul.

Table II.1 Program List (<http://www.marmara.edu.tr/en/academic/faculties>)

	B.Sc	M.Sc	Ph.D.
Bioengineering		✓	
Chemical Engineering	✓	✓	✓
Civil Engineering			
Computer Engineering	✓	✓	
Electrical and Electronics Engineering			
Environmental Engineering	✓	✓	✓
Industrial Engineering	✓	✓	✓
Materials Engineering	✓	✓	
Mechanical Engineering	✓	✓	✓

In the Faculty of Engineering, the following departments provide education: Computer Engineering, Bioengineering, Environmental Engineering, Industrial Engineering, Mechanical Engineering, Materials Engineering and Chemical Engineering. The Electrical and Electronics Engineering and Civil Engineering departments will begin providing education after their establishment phase is completed (<http://www.marmara.edu.tr/en/information/history>). Currently ongoing B.Sc. (Bachelor of Science), M.Sc. (Master of Science) and Ph.D. (Philosophy of Doctorate) programs are listed in the Table II.1. Additionally, M.Sc. and Ph.D. degrees are awarded in Management Information Systems which are interdisciplinary program between Management and Information Systems.

The main goal of IE (Industrial Engineering) is to improve the productivity and competitiveness of organizations. IEs are, in general employed in sectors such as manufacturing, energy, health, finance, telecommunications, transportation, information and data processing. In these sectors, contemporary performance measures of responsiveness, cost, quality, and flexibility are part of implementation and management of systems.

The principle of education at the Industrial Engineering Program of Marmara University is to create leaders for the future of Turkey who can easily adapt to the developments and changes in the work environment and who are skilled at teamwork. Industrial engineers are armed and equipped with the necessary formation to deploy scientific methods in decision-making environments.

The Industrial Engineering Department accepts students every year who are rated in the top 1-2% of the University Entrance Central Exam in Turkish education system; students are offered various courses in research programs. The academic program focuses on the design, analysis, improvement, installation, operation and control of systems. The curriculum meets the ABET (The American Board of Engineering and Technology) criteria and medium of instruction is English. In their senior year, the students form teams to conduct a graduation project. The projects are typically chosen from the places in which they performed their summer training, and aim to solve a particular real-life engineering problem.

Graduate Programs, which are of primary importance for the 21st century, are those that will improve the quality of education and research. Projects, which aim to restructure and improve the University, and to effectively educate and simulate future scientists and technicians, are now being implemented. The department has

two graduate programs, namely IE, which offers MSc and PhD degrees, and MIS (Management Information Systems), which is a non-thesis MSc program. (<http://fbe.marmara.edu.tr/websayfalari/mbabd/endustri.html>).

Marmara University Faculty of Engineering administration chart is shown in Figure II.1.

MARMARA UNIVERSITY FACULTY OF ENGINEERING

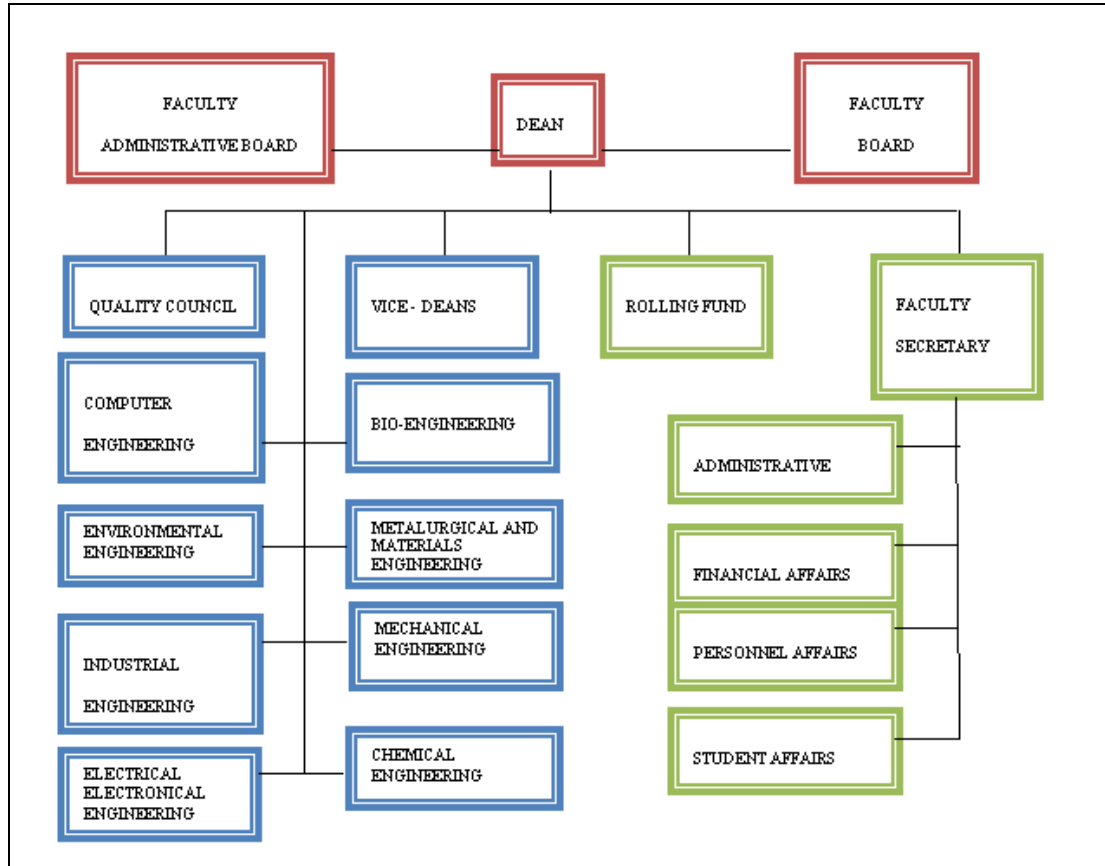


Figure II.1 Marmara University Faculty of Engineering

II.2. HISTORY OF MARMARA UNIVERSITY

Marmara University is recognized as one of the leading higher education institutions in Turkey due to its perfectionist approach to balancing universal knowledge with the moral values. In almost all fields, Marmara University, with its long and successful history, has become a modern and international university which hosts and participates in scientific meetings, cultural activities, art and sports along with various other national and international events. The university is one of the few Turkish universities, which is a member of the EUA (European University Association), and carries out its international studies through ABET and in the

process of preparation for the quality assessment carried out by EQUIS (European Quality Improvement System), an international system of accreditation in management and business administration in Europe. The Institute of Social Sciences is now an institutional member of EFMD (European Foundation for Management Development). Techno-manager capabilities play a very crucial role in the development of processes of industrialized countries.

In 1990, Marmara University Industrial Engineering was established and received its first group of undergraduate students in the 1990-91 academic years with the aim of producing human power, which was needed in these development processes.

II.3. LITERATURE REVIEW

In this study, Literature Review has been conducted in two parts. The first and the main part of Literature Review was about Six Sigma, the second part was about Qualitative Analysis Methodology. Qualitative Analysis Methodology has been used in Six Sigma's DMAIC Methodology. Literature Reviews for Six Sigma and Qualitative Analysis Methodology were described in detail in following two sections.

II.3.1. Six Sigma Literature Review

The literature review for Six Sigma showed that most applications were limited to service industries in North America and European countries and there were only few number of applications related to manufacturing industries in Asian countries.

The term Six Sigma was generated at the beginning of 1987 at Motorola. Basically, its purpose was to improve company performance by analyzing variations in its processes (Harry and Schroeder, 2000). The obtained results earned Motorola Company the Malcolm Baldrige Award for Quality in 1988 and Six Sigma was credited with the organization's success. This situation resulted in promotion for Six Sigma. For that reason, other companies were encouraged to incorporate the methodology. Since then, Six Sigma has been adopted by various industrial sectors.

An important benchmark was Six Sigma application of the GE (General Electric) Company, which was one of the leaders in implementing the process. Initially, the goal of Six Sigma was to focus on the manufacturing process, later on the goal started to focus on distribution, marketing, customer order processing functions as well as service operations (Wessel and Burcher, 2004).

Six Sigma simply means a measure of quality that struggles for near perfection for many organizations. Six Sigma is a disciplined data analysis approach and methodology for eliminating defects in any process from manufacturing to transactional and from product to service. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects and minimizing variability in manufacturing and business process.

Six Sigma is well known methodology for quality improvement by reducing variations from the output requirement consideration (Harry, 2000). Six Sigma level of an organization characterizes the calibration of process performance by using statistical tools in manufacturing sector. This becomes a means of enhancing the competitiveness of this organization towards business excellent. Six Sigma is also productive on voice of customers through CTQ (Critical To Quality) and establishing DMAIC framework as a data concentrated systematic approach (Anthony, 2006).

The main focus of Six Sigma is to reduce variations in processes continuously and thus eliminate defects or faults in products or in services. Six Sigma is stated as a management practice that aims to improve company profitability in products or services in companies of any size (small, medium or large). Six Sigma strives for the purpose of increasing market share and quality, reducing costs and optimizing operations (Wessel and Burcher, 2004).

Primarily, the financial benefits of Six Sigma have been publicized rather than discussions of enhancement in terms of process improvement. Also, it is important to note that the applications highlight the proper identification of critical success factors (CSFs), CTQ characteristics, and KPIs (Key Performance Indicators).

Basically, critical factors are identified such as managements' commitment, education and training, culture change within the company and financial benefits. These factors are the most important CSFs for the successful application of Six Sigma in services. According to the applications, other CSFs include customer focus, performance metrics, and the organizational understanding of work processes. Additionally, there are several critical factors for successful Six Sigma implementation. They can be summarized as; a previous quality program adoption, top management leadership, managerial processes.

Dean and Bowen (2003) introduced development of Six Sigma Method by comparing total quality and management theory at both topic specific and global

levels. This analysis suggested that incorporating some values of total quality into management theory could enhance management research.

A quality management program can be characterized by its principles, practices and techniques. In the program, the principles provide general guidelines, which are implemented through the practices that are supported by several techniques. In comparison, principles are too general for empirical research and techniques are too detailed to obtain reliable results (Sousa and Voss, 2004). This means that a quality management program can only be successful by implementing principles, practices and techniques phase by phase.

According to Antony and Banuelas (2005) based on a survey of UK companies, the key components for Six Sigma implementation included management involvement and commitment, comprehension of Six Sigma, and connecting Six Sigma to business strategy.

In manufacturing industry, much of the Six Sigma literature was published by practitioners who worked in major companies such as GE, Motorola, Honeywell, etc. that used Six Sigma. For example in Pande et al. (2007), “The Six Sigma Way” was written based on the authors’ experiences in companies such as GE and Motorola. It presented an executive overview of Six Sigma, which included how to adapt an organization to this method in addition to a roadmap and tools for performing this adaptation. Table II.2 provides a summary of some publications about Six Sigma. It includes some relevant topics that can be found in the referred journals and papers.

Table II.2 Brief Summary of the Six Sigma Literature

SIX SIGMA TOPICS	REFERENCES
Case Studies	(Pande et al., 2000); (Eckes, 2001); (Motwani et al., 2004)
Lean Production	(Arnheiter and Maleyeff, 2005); (Andersson et al., 2006)
Implementation	(Breyfogle et al., 2005); (Bañuelas and Antony, 2002)
Health Care	(Taner et al., 2007)
Service	(Hensley and Dobie, 2005); (Antony et al., 2006); (Chakrabarty and Tan, 2007)
Quality Cost	(Bo, 2005); (Min, 2006)
Management Mode	(Bin-feng and Zhi-xin, 2003);

Table II.2 Brief Summary of the Six Sigma Literature (Continued)

TQM (Total Quality Management)	(Bin-feng and Zhi-xin, 2003); (Bo, 2005); (Sheng-li, 2005)
Integration	(Guang-ling and Chun-hua, 2006)
Lean Production	(Feng-zhang and Ming-peng, 2004)
None	(Yuan-yuan, 2006), (Harry and Schroeder, 2000)

The Literature Review can be grouped in terms of quality, Six Sigma role structure, structured improvement procedure, focus on metrics and implementation in service.

About Quality:

Six Sigma was developed as a set of practices designed to improve manufacturing processes and eliminate defects. But, its applications have been subsequently extended to other types of business processes as well. It also depends on using extensive data and information to identify and solve problems. Information and data are collected about customer needs and expectations, products, services and business processes. Then, they are analyzed to generate improvement ideas, examine improvement activities, evaluate and keep improvement outcomes.

The usage of quality information in Six Sigma effectively is connected with the metrics used in Six Sigma. Six Sigma emphasizes linking quality improvement with the most important benefits, for that reason the metrics incorporate the most important performance measures with the measures of quality defects. In order to provide appropriate data for evaluating those metrics, the content of quality information must contain both operational and financial data. (Breyfogle et al., 2005)

Six Sigma role structure:

The employees in a Six Sigma Prosedure are classified into the levels based on their knowledge and experience regarding quality management. These levels are names such as champion, master black belt, black belt, and green belt. Characteristically, champions are usually executive-level managers who promote and lead the deployment of Six Sigma in a significant area of the business. Master black belts are statistical experts who are quality leaders responsible for Six Sigma strategy, training, guiding, operation, and results. Black belts are generally project managers who lead improvement teams, work on projects in the business, and advice green belts.

Green belts manage the processes of the Six Sigma projects, and they have some quantitative skills as well as teaching and leadership capability. Also, green belts are responsible for ensuring the smooth improvements of the processes, for communicating in the process knowledge, for obtaining required approval for any process changes, for choosing team members, and for keeping up team motivation and responsibility.

Basically, teams composed of members carrying out the above roles perform Six Sigma improvement projects. This role structure refines the employees' roles so that they know their responsibilities and their benefits of their participation in continuous improvement efforts. For that reason, this role structure may increase the employees' contribution to Six Sigma. Also, this role structure requires that each belt receive training in leadership skills, technical skills, and team effort skills that are appropriate to their ranks. Six Sigma includes different training programs to employees to increase training effectiveness (Devane, 2006).

Structured improvement procedure:

Six Sigma uses an exact and prescribed procedure to conduct improvement projects, which is DMAIC.

DMAIC is a standardized process that is composed of specific problem solving steps with appropriate qualitative and quantitative tools in each step. This procedure provides a methodological structure to assist improvement teams to select possible projects, to design solutions that are maintainable once applied, and to understand how certain statistical tools should be used in each improvement step to produce an output (Devane, 2006). DMAIC procedure will be explained in detail in Part IV.

Barriers and Challenges in Implementation of Continuous Improvement

Although, the most common barrier in implementation in Six Sigma is “resistance to change”, several other unique barriers were identified. Those included were, a lack of cohesive business strategy, budget and time constraints, and fractured organizational cultures. The data identified several methods to overcome deployment barriers but it appeared that the most significant was senior level involvement. (O'Rourke, 2005)

The implementation of continuous Improvement challenges identified by (O'Rourke, 2005) was:

- 1) Resistance to change
- 2) Budget and time constraints

- 3) Unique implementation by internal organizations
- 4) Black Belt candidate selection process

Additionally, Liker and Thomas (1998) defined implementation challenges of continuous improvement programs as:

- 1) Ingrained employee resistance
- 2) Managers' difficulty in managing production and continuous improvement efforts
- 3) Top managers' vision of launching continuous improvement projects
- 4) Lack of management to extend continuous improvement throughout the organization ,
- 5) Lack of management to permit worker participation ,
- 6) Lack of integration of continuous improvement teams with standard workers
- 7) Internal political tension
- 8) Lack of management support for continuous improvement efforts
- 9) Trying to sell and apply continuous improvement changes without management support

Focus on metrics:

Six Sigma emphasizes and integrates using metrics to generate and control actions where improvements are required. Six Sigma also integrates the traditional quality metrics with some additional metrics to create a more comprehensive measurement system for quality management.

The fundamental metrics of Six Sigma can be listed as;

- 1) Reducing general defects
- 2) Finding and fixing defects closer to their point of creation
- 3) Predicting and tracking defect emergence and removal rates and repair costs
- 4) Comparing implementations in the company
- 5) Comparing implementations to the other companies.

The statistical meaning of Six Sigma, 6σ , is a measure for evaluating process quality. It means 3.4 DPMO (Defects Per Million Opportunities). DPMO is a meaningful comparison of number of defects for different work products when normalization for quantity is needed. Typical Six Sigma metrics include DPU (Defects Per Unit), which is proportion of defective product. These metrics assess

how well a process performs in order to guide where and how to conduct appropriate improvement activities, and they evaluate improvement outcomes as well.

Six Sigma uses the metrics with three features. First, the metrics and relevant tools are integrated with Six Sigma's structured improvement procedure. Throughout the DMAIC's five steps, metrics are used to choose a project, to develop a Project plan, to collect and analyze data, and to evaluate project outcomes. This integration of metrics and tools into the formalized DMAIC procedure is unique to Six Sigma.

Secondly, Six Sigma takes business level performance measurements into consideration when developing metrics for project selection and evaluation (Gupta, 2004). Six Sigma metrics help companies make decisions through a systematic consideration of both short and long-term performance, and nonfinancial and financial performance by connecting operational performance with financial and marketing performance.

Third, Six Sigma metrics are defined and measured to provide clear, explicit, precise and challenging goals for continuous improvement. In Six Sigma, goal definition starts in the early phases of a Six Sigma improvement project. Data are collected from the process performance measures like DPMO and/or Six Sigma Process.

Implementation in Service:

An important phase of Six Sigma is its implementation. There are key ingredients that are necessary to the process of structuring the application within the organizations for effective implementation. These key ingredients are management's commitment to the application, the existence of organizational infrastructure sufficient to assure the introduction, growth and continuity of the application, the selection and training of the professionals involved in Six Sigma, and an effective selection of projects.

As pointed out by many researchers including (Bank, 2000) and (George, 2003) there were several expected benefits from implementing Six Sigma in the banking sector. These benefits included reduction in customers' complaints, reduction in internal call backs, reduction flaws in all customer facing processes, significant decrease in the number of returned renewal credit cards, identifying and eliminating defects and mistakes in business processes, reduction in administration cost, and reduction in costs associated with order corrections.

Similarly, as a result of Six Sigma implementation, Anthony (2006) listed some of the benefits obtained by the financial institutions. These benefits were: reduction in internal call backs by 80 per cent, external call backs by 85 per cent and credit processing time by 50 per cent, reduction in the cycle time from customers placing an to service delivery and the credit decision cycle by 67 per cent, reduction statement processing cycle time from 28 to 15 days and increased customer satisfaction and improved efficiency and cycle times by over 30 per cent.

More importantly, Chakrabarty and Tan (2007) have reviewed large numbers of articles concerning Six Sigma in services and sorted their results on articles on the same topic. Chakrabarty and Tan (2007) believed that Six Sigma is difficult to implement in services because services' processes could not be altered easily. Moreover, they stressed the emphasis on CSF of Six Sigma implementation in both manufacturing as well as in service sectors. These CFSs included top management commitment, education and training, cultural changes, customer focus, clear performance metrics, attaching the success of financial benefits, and organized understanding of work process.

Similar to previously stated paper, Hensley and Dobie (2005) outlined the following difficulties in using Six Sigma in services. These difficulties were gathering data, measuring customer satisfaction, quantifying and measuring data of associate process since data collection was not automated like in manufacturing, cultural change, organizational infrastructure, linking Six Sigma to business strategy and linking Six Sigma to customer. According to Hensley and Dobie (2005) these difficulties were in line with the limitations expressed by Chakrabarty and Tan (2007).

In the same manner, researchers such as Anthony (2006), Chakrabarty and Tan (2007) were supportive of applying the DMAIC Methodology as the best way to implement Six Sigma in both manufacturing and service sectors. Properties of Six Sigma based on the recent literature are summarized in Table II.3.

Table II.3 Literature Summary for Properties of Six Sigma

PROPERTIES	SIX SIGMA
Financial Savings	Keeps the track of savings for each Project (Schroeder et al., 2008). Focuses on finance (Kwak and Anbari, 2004)
Motivations	Includes less challenge to have motivations to chase improvement (Terziovski, 2006).
Strategic Link	Provides better alignment with the objectives of organizational strategic business (Antony, 2006).
Project Selection	Project selection rights belong to management to make certain financial and strategic implications are considered (Schroeder et al., 2008).
Training Focus	Focuses on training to Belts or levels (Basu, 2004) that create an infrastructure for implementation (Terziovski, 2006) without focus on wide team participation (Schroeder et al., 2008).
Functional Team	Uses an organizational cross functional improvement team (Basu, 2004).
Criticized For	Does not focus on all people and culture (Linderman et al., 2008). However, it is less difficult to re-engineer and evaluate disintegration of an organization using Six Sigma as the team is more independent of the processes under concern. (Hwang, 2006). It is criticized for focusing on tools not problems (Linderman et al., 2008)
Training Intensity	Has more intensity in the training of full-time improvement of individuals (Schroeder et al., 2008).
Motivation	Driven by real benefits (Motwani et al., 2004).
Suppliers	Targets supplier only if critical to quality of studied process (Schroeder et al., 2008).
Progress Monitoring	Has a mix of long and short-term focus with better monitoring of progress toward goals (Motwani et al., 2004).
Structure	It is a project-focused approach using DMAIC, reinforcing Juan belief (Basu, 2004) and a well structured DMAIC road map for deployment (Terziovski, 2006). A key strength in it is that it builds a quality improvement structure in parallel to existing management structure (Motwani et al., 2004).

Table II.3 Literature Summary for Properties of Six Sigma (Continued)

Tools	Has a new approach to Continuous Improvement (Banuelas and Antony, 2002). Have additional data analysis tools (Kwak and Anbari, 2004) with more statistical emphasis (Basu, 2004).
Performance Target	Its performance target applies to a single critical quality characteristic (Banuelas and Antony, 2002). Sigma level can be used in assessing quality level attained or in benchmarks (Klefsjo et al., 2001).
Results	Since its beginning, Six Sigma has a better record (Antony, 2006).

II.3.2. Qualitative Analysis Literature Review

Many leading journals began to publish Qualitative Research articles by the end of the 1970s (Loseke and Cahil, 2007). In the 1980s and 1990s, the new Qualitative Research journals became more multidisciplinary in terms of focus fields. They moved beyond Qualitative Research's traditional disciplinary roots of anthropology, sociology, and philosophy (Loseke and Cahil, 2007).

The brief summary of Qualitative Analysis Literature is shown in Table II.4 in terms of characteristics.

Table II.4 Literature Summary for the Qualitative Analysis Characteristics

CHARACTERISTICS OF QUALITATIVE ANALYSIS	REFERENCES
Verbal Descriptions	(Glanz, 2006)
Naturalistic	(Scribe, 2006)
Tentative Hypotheses	(Struck and White, 2000)
Flexible	(White et al., 2001)
Reality is constructed	(Whittemore et al., 2006)
Involved	(Loseke and Cahil, 2007).
Inductive	(Whyte, 2001)
Emergent	(Wiener, 2005)
Develops Understanding	(Williams, 2004)
Specific to Situation	(Linderman et al., 2008)
Describes the "how"	(Wolcott, 2001)

Several new journals, which published only Qualitative Research studies and articles about Qualitative Research Methodology, appeared since 1990s. The new millennium saw a dramatic increase in the number of journals specializing in Qualitative Research with at least one new Qualitative Research journal being launched each year.

The brief summaries of Qualitative Analysis Methodology Techniques are tabulated in Table II.5.

Table II.5 Literature Summary of Qualitative Analysis Methodology Techniques

QUALITATIVE ANALYSIS TECHNIQUES	REFERENCES
Ethnography	(Webb, 2002)
Interviews	(Weiss, 2007)
Observations	(Woodfield, 2003)
Case Study	(Yin, 2004)
Historical	(Weitzman and Miles, 2005)
Phenomenological	(White et al., 2001)
Grounded Theory	(Weitzman et al., 2005)

II.4. RESEARCH METHODOLOGY

In this study, the Qualitative Analysis Methodology was used to improve the educational processes in MUFE. The Dean of the Engineering Faculty, the assistant dean and faculty members of the management board were interviewed as to identify problematic areas in the Marmara University Industrial Engineering Department.

In order to research the education and training for use in subsequent years, the education processes were required to be examined. The Academic processes, knowledge and experience familiar to the faculty members were used. Throughout the observations, the possibility of increased efficiency and quality in education for facilities was examined. With the goal of increasing and improving the quality and efficiency of academic processes, the results of the MUFE study were used.

The academic education processes were investigated and the information was collected by using the Qualitative Analysis Methodology in the stages of the Six Sigma Application. Detailed information about Qualitative Research will be given in Part III.

Six Sigma approach has been used to address the issues identified in the study. Klefsjo et al. (2001) argued that case studies are particularly appropriate in areas where theory wasn't well developed and that they were a basis for scientific research. Anthony (2006) classified case studies into explanatory, descriptive and exploratory approaches. Anthony (2006) stated that to differentiate among these approaches, it was necessary to examine the type of research question being posed. Detailed information about Six Sigma will be given in Part IV.

PART III

QUALITATIVE RESEARCH

Qualitative Research specializes in the design, conduct and interpretation of research studies using in-depth interviews and focus groups.

Qualitative Research has been developed over several decades. They have been refined and improved in response to a wide range of applications. There is particular importance on data generated through in depth interviews. This interview means that much attention shall be given to the study of naturally occurring data, such as observation, documentary analysis, and discourse and conversation analysis. Many of the principles described in relation to working with interviews have significance for the full range of Qualitative Researches (Ritchie , 2006).

The “quality” of Qualitative Research has been discussed as follows;

“.... Pragmatic social researchers can use philosophical and political debates as resources for achieving certain mental attitudes, rather than a set of underlying principles from which all else must flow, creating unnecessary obstacles to flexible and creative inquiry ... One can, then, understand such debates as conversations stimulating methodological awareness among researchers, rather than laying foundations for truth.” (Ritchie , 2006)

III.1. DEFINING QUALITATIVE RESEARCH

Qualitative Research shall be described in order to assess the value and appropriateness of the research practices, The discussion of Qualitative Research commences with some attempts to define what is meant by this term, either theoretically or practically, or both. (Williams, 2005) offers the following definition:

“Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that makes the world visible. These practices ... turn the world into a series of representations including field notes, interviews, conversations, photographs, recordings and memos to the self.

At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them.”

III.1.1. The Basics of Qualitative Research

The basics of Qualitative Research can be grouped into three sub groups. First, it is important to distinguish that there is no single, accepted way of doing Qualitative Research. It depends on a range of factors including:

- 1) Researcher’s beliefs about the nature of the social world and what can be known about it,
- 2) The nature of knowledge and how it can be acquired,
- 3) The purposes and goals of the research, the characteristics of the research participants,
- 4) The audience for the research,
- 5) The founders of the research,
- 6) The position and environment of the researchers themselves.

Secondly, there is general agreement that an understanding of the background of the study shall encourage and contribute to better research practices.

Finally, it is important to appreciate that there is no one right and accepted way of doing Qualitative Research and its methods. There is a particular mix of philosophy, research objectives, participants, funders and audiences relevant to applied policy research (Williams, 2005).

III.1.2. The Historical Development of Qualitative Research

The history of Qualitative Research should be narrated and appreciated within the wider context of the evolution of social research. Indeed, despite their different origins and assumptions, both qualitative and quantitative research methods have unique and valuable contributions to make to social research practice (Yin, 2004). In this study, the methods and applications of Qualitative Research have been emphasized in stead of historical development in detail.

III.1.3. The Applications of Qualitative Methods to Social Research

In general, theoretical research is concerned with the aim of testing, generating or improving thinking within a particular discipline. Basic researchers work to generate new theories or test existing theories.

Applied research is related to using the knowledge acquired through research to give directly to the understanding or resolution of a current issue. Similarly, its purposes are generally set or shaped by specific information requirements or by the requirement to gain insight into an existing problem.

The objectives of the research may understand underlying social problems or receiving cultures. On the other hand, the objectives may be highly focused on specific services, interventions or application (Ritchie , 2006).

III.1.4. The Functions of Different Qualitative Methods

There are mainly two approaches to collect qualitative data. Firstly, data collection focuses on naturally occurring data and secondly, the generation of data through the interview of research.

Naturally occurring data;

Many of the methods used in Qualitative Research are expanded to allow the investigation of phenomena in their natural settings.

There have been a number of different approaches that have been developed to study phenomena in naturally occurring settings. These include;

- 1) The researcher joins the study population or its organizational or community setting to record actions, interactions or events that occur. This also enables the researcher to have the opportunity in order to gain additional insights through experiencing the phenomena (Jorgenson, 2008).
- 2) Observation offers the opportunity to record and analyze behaviour and interactions as they occur, although not as a member of the study population.

Documentary analysis involves the study of existing documents, either to understand their substantive content or to clarify deeper meanings, which may be exposed by their style and coverage.

Discourse analysis examines the construction of texts and verbal accounts to explore “systems of social meaning”. It examines ways in which “versions of the world, of society, events and inner psychological worlds are produced in discourse” (Tonkiss, 2000) with an interest in both their cognitive conception and their interpretation for social action.

The generation of data through the interview;

Conversation analysis involves a detailed examination of “talk in interaction” to determine how conversation is constructed and enacted. The aim is to investigate social intercourse, as it occurs in natural settings, in “an attempt to describe people's methods for producing orderly social interaction” (Silverman, 2001).

Recording A good quality tape recorder is essential, with a remote multidirectional microphone. The tape recorder is usually positioned adjacent to the researcher, with the microphone in the centre of the table. People starting out often find that their biggest disappointment is not the way the discussion went, but that their recording of it has failed because they were unfamiliar with the equipment. Before the participants arrive it is essential to check that the tape recorder is functioning: that the recording level is appropriate, the batteries charged, tape inserted, and that a spare tape is to hand. After the discussion has ended, checks should be made as soon as possible that no technical problems have prevented recording (Silverman, 2001).

In this study, primarily conversation analysis and partially recording have been applied for Qualitative Research.

III.1.5. Methods of Analysis

There are six steps of Qualitative Analysis

- 1) Processes describe their lived world during the interview.
- 2) Processes themselves discover new relationships during the interview, see new meanings in what they see and do.
- 3) The interviewer concentrates and interprets the meaning of what the applicant describes during the interview. Ideally interviews last until there is only one possible interpretation left or the multiple understandings of a theme by the subject are known.
- 4) The interviewer interprets the recorded interview, either alone or with other researchers. The material is first arranged. Then follows clarification by

eliminating deviations and repetitions and distinguishes between important results and unimportant results. The correct analysis involves developing the meanings of the interviews, bringing the subjects' own understanding into the light and providing new perspectives from the researcher on the phenomena.

- 5) At the re-interview, the subjects get the opportunity to comment on the interviewer's interpretations as well as expand on their own original statements.

III.2. QUALITATIVE RESEARCH TECHNIQUES

There are two variables to consider in order to determining the most effective methodology to use (Patton, 2002). The first is the current state of research in the proposed area of study. The second issue to take into consideration when deciding on a research methodology is the proposed research goals. The researcher shall explore the concepts and processes of performance, interaction and interpretation of variable objects.

The term qualitative entails an emphasis on the examination of the processes and meanings, but not measured in terms of quantity, amount, or frequency. Generally, Qualitative Methods produce a lot of detailed data about a small number of cases, and provide a depth of detail through direct quotation, precise description of situations and close observation.

The strength of Qualitative Research is that it attempts to show the completeness of experience in a meaningful and comprehensive way. Qualitative Research is the most appropriate for those projects where phenomena remain unexplained, where the nature of the research is broad, where earlier theories are not present or are incomplete and where the goal is deep narrative understanding or theory development. Qualitative Methods for data collection generally include participant observation, open-ended or semi-structured interviews, and qualitative content analysis of documents.

In this study, Qualitative Analysis Methodology was used within the Define, Measure and Improve (Solution) Phases of DMAIC Methodology of the Six Sigma. During Define, Measure and Improve (solution) phases, interviews with faculty members were completed.

There were five kinds of Qualitative Research studies in the literature (Leedy and Ormrod, 2005):

- 1) Case Studies
- 2) Ethnographies
- 3) Phenomenological Studies
- 4) Grounded Theory Studies
- 5) Content Analysis

Types of Qualitative Research studies were described in detail below. In this study, Case Study of the Qualitative Analysis was used primarily. Table III.1 contains the aims and research traditions of the Qualitative Analysis. “Sociology” in Table III.1 was included in this study as Disciplinary Origins.

Table III.1 Traditions of Qualitative Research

Research Tradition	Disciplinary Origins	Aims
Ethnography	Anthropology/ Sociology	Understanding the social world of people being studied through immersion in their community to produce detailed description of people, their culture and beliefs.
Phenomenology/ Ethnomethodology	Philosophy/ Sociology	Understanding the “constructs” people use in everyday life to make sense of their world. Uncovering meanings contained within conversation or text.
Leading to Conversation analysis	Sociology/ Linguistics	Analysing the way different Conversations are structured and the meanings they contain.
Discourse analysis	Sociology	Examining the way knowledge is produced within different discourses and the performances, linguistic styles and rhetorical devices used in particular accounts.
Protocol analysis	Psychology	Examining and drawing inference about the cognitive processes that underlie the performance of tasks.

Table III.1 Traditions of Qualitative Research (Continued)

Symbolic Interactionism	Sociology/ Social Psychology	Exploring behavior and social roles to understand how people interpret and react to their environment.
Leading to Grounded theory	Sociology	Developing “emergent” theories of social action through the identification of analytical categories and the relationships between them.
Ethogenics	Social Psychology	Exploring the underlying structure of behavioral acts by investigating the meaning people attach to them.
Constructivism	Sociology	Displaying “multiple constructed realities” through the shared investigation (by researchers and participants) of meanings and explanations.
Critical theory	Sociology	Identifying ways in which material conditions (economic, political, gender, ethnic) influence beliefs, behavior and experiences

III.2.1. Case Studies

In a case study, a particular individual, program or event is studied in depth for a defined period of time.

Method: In a case study, the researcher collects extensive data on the individuals, programs or events or single event on which the investigation is focused.

Data Analysis involves the following steps:

- 1) Organization of details about the case.
- 2) Categorization of data.
- 3) Interpretation of single instances.
- 4) Identification of patterns.
- 5) Synthesis and generalization.

The Research Report includes following:

- 1) A rationale for studying the case.
- 2) A detailed description of the facts related to the case.
- 3) A description of the data you collected.
- 4) A discussion of the patterns you found.
- 5) A connection to the larger scheme of things.

A case study is one of the several ways of doing research whether it is related to social science or even socially related. Basically, it is an intensive study of a single group, incident, or community. Other ways include experiments, surveys, or analysis of archival information.

A case study should be defined as a research strategy, for that reason it should initiate an empirical inquiry that examines a researched phenomenon within its real life context. Case studies can be based on any mix of quantitative and qualitative evidence. Single subject research provides the statistical framework for making inferences from quantitative case study data. This is also supported and well-formulated in (Lamnek, 2005) as;

"...The case study is a research approach, situated between concrete data taking techniques and methodological paradigms."

Case study methods involve an in detail, longitudinal examination of a single instance or event, which is a case. Case study methods provide a systematic way of exploring events, collecting data, analyzing information, and reporting the results. As a result, the researcher may gain a direct understanding of why the instance happened as it did, and what might become important to look at more extensively in future research. In this study case study method was used while determining the educational process.

III.2.2. Ethnography

It is a methodological strategy used to provide explanations of human societies, which as a methodology does not set down any observation, interview, or questionnaire. Instead, ethnography sets down the nature of the study by describing people through writing.

In a case study, the researcher looks at a particular person, program or event in considerable depth. Contrast to case study, in ethnography the researcher looks at an

entire group more specifically. Entire group is believed to share a common culture in detail. The researcher studies the group in its natural setting for a lengthy period of time, often several months or several years.

Data Analysis involves the following steps:

- 1) Description.
- 2) Analysis.
- 3) Interpretation.

Ethnographic research attempts to fully describe a variety of aspects and norms of a cultural group to enhance understanding of the people being studied (<http://en.wikipedia.org/wiki/Ethnography>).

III.2.3. Phenomenological Study

A phenomenological study is a study that tries to understand people's perceptions, perspectives, and understandings of a particular situation.

Method: Phenomenological researchers depend almost completely on lengthy interview with a carefully selected sample of participants.

Data Analysis involves the following steps:

- 1) Identifying statements that relate to the topic.
- 2) Grouping statements into "meaning units".
- 3) Seeking different perspective.
- 4) Constructing a combination (Leedy and Ormrod, 2005).

III.2.4. GT (Grounded Theory) Study

GT is a systematic Qualitative Research Methodology in the social sciences emphasizing generation of theory from data in the process of conducting research. The major purpose of a GT approach is to begin with the data and use them to develop a theory. More specifically, a GT study uses a prescribed set of procedures for analyzing data and constructing a theoretical model from them.

Method: Data collection is based on field study, flexible, and likely to change over the course of study. Interviews typically play a major role in data collection, but observations, documents, historical records, video, tapes and anything else of potential relevance to the research question may also be used.

Data Analysis involves the following steps:

- 1) Open coding
- 2) Axial coding
- 3) Selective coding
- 4) Development of a theory

In most behavioural research, attempts, persons or patients are units of analysis, whereas in GT the unit of analysis is the incident (Strauss, 2006).

III.2.5. Content Analysis

A content analysis is a detailed and systematic assessment of the contents of a particular material for the purpose of identifying patterns, themes and biases. Content analyses are typically performed on forms of human communication, including books, newspapers, films, television, art, music, and transcription of conversations.

Method involves the following steps:

- 1) The researcher identifies the specific material to be studied.
- 2) The researcher defines the characteristics or qualities to be examined in exact, actual terms.
- 3) If the material to be analyzed involves complex or extended items, the researcher breaks down each item into small, manageable sections that are analyzed separately.
- 4) The researcher arranges the material for instances of each characteristic / quality.

Qualitatively, content analysis can involve any kind of analysis where communication content such as speech, written text, interviews, or images are categorized and classified. Robert (2005) states that:

"...To make valid inferences from the text, it is important that the classification procedure be reliable in the sense of being consistent: Different people should code the same text in the same way."

Robert (2005) has highlighted the difference between prescriptive analysis and open analysis. In prescriptive analysis, the context is a closely defined set of communication parameters like specific messages and subject matter. The open analysis identifies the dominant messages and subject matter within the text.

PART IV

THE SIX SIGMA METHODOLOGY AND APPLICATION

Six Sigma is regarded as a powerful strategy for employing a continuous improvement methodology to effectively reduce process variability and increase quality in academic processes using qualitative and quantitative tools.

However, the literature still contains a few empirical studies of Six-Sigma approach. This study describes a procedure that applies Six Sigma approach to enhance quality in university. This empirical study illustrated methods used to apply Define, Measure, Analyze, Improve and Control (DMAIC) approach of Six Sigma. The Six Sigma empirical study mentioned the functions and efficiency of academic process, and the same process would be improved in the MUFE.

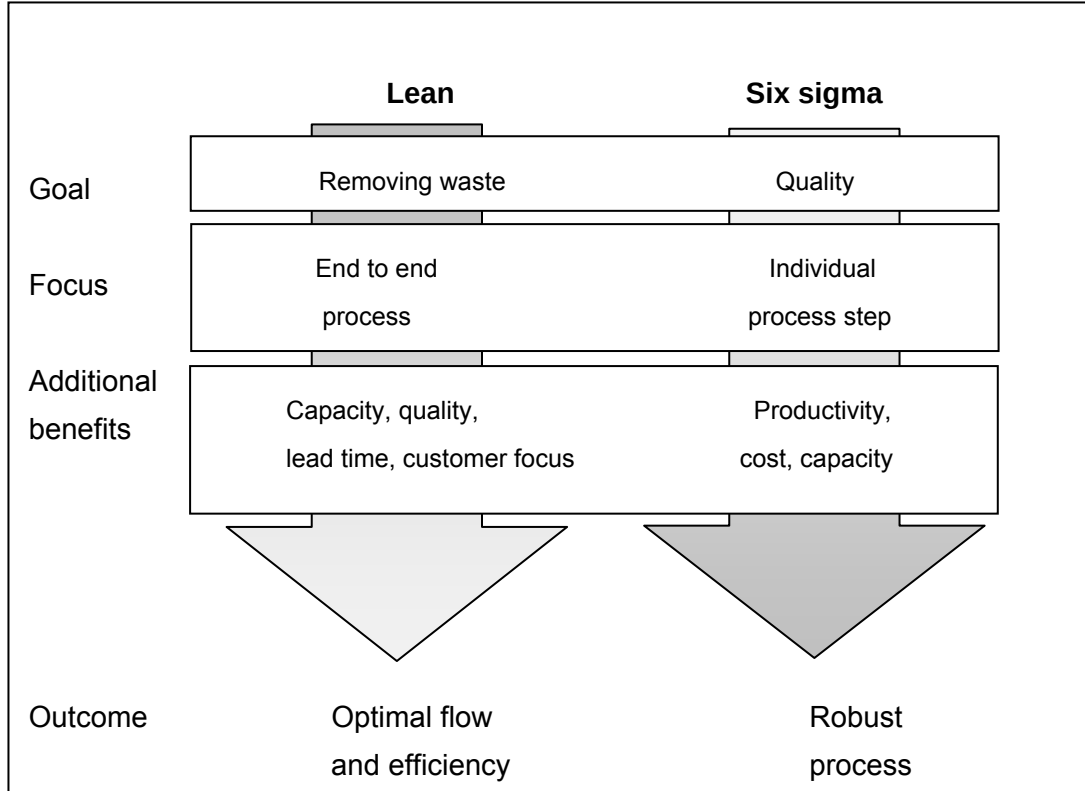


Figure IV.1 Lean and Six Sigma (<http://www.drugdiscoverytoday.com>)

However, Six Sigma should not be applied everywhere, in some practices it will be more suitable to apply with Lean approach. A toolbox of complementary methods has been developed based on principles taken from Six Sigma to improve the processes. Although often applied separately, Lean and Six Sigma were complementary and were ideally applied in a modular fashion to address problems for single process steps, as well as the continuous work flow. Figure IV.1 illustrates a suitable system for the combined application of Lean and Six Sigma.

Six Sigma is an integrated, disciplined approach for decreasing defects by using measurable financial results. With its bases in statistical engineering, this concept includes a data driven methodology focused on degrading variations. While Lean serves to reduce waste, Six Sigma decreases process variability in motivation for improvement. (Taninecz, 2005)

IV.1. SIX SIGMA APPROACH

Six Sigma has been defined as the latest management concept to merge previous quality management principles, practices, applications and tools/techniques. At first glance, Six Sigma resembled remarkably similar previous quality management approaches. On the other hand, global organizations with a quality track record, which have adopted Six Sigma, claimed that it has transformed and improved their organization (Daft, 2001).

The way Six Sigma is practiced represents a new organization structural approach to improvement. Six Sigma helps an organization become more qualified by providing an exchanged structure. Six Sigma allows the organization to act more organically in coming up with new improvement ideas. Additionally, the structure of Six Sigma employs very many mechanisms that concurrently advance the contradictory demands of exploration and control in the improvement effort. Therefore, the basic issue in Six Sigma when compared to previous quality management approaches is more its organizational implementation rather than the underlying philosophy or the quality tools/techniques employed (Daft, 2001).

Six Sigma attempts to recognize and eliminate the causes of defects and errors in manufacturing and business processes. It uses a set of quality management methods, containing statistical methods, and generates a special foundation of people within the organization who are experts in these methods.

A main principle of the Six Sigma philosophy is that it is usually the process that needs reworking when performance standards are not being met.

Six Sigma methods and work approaches are required to be inserted in an organization's culture and in the way people do their everyday jobs. This process begins with development of a strategic plan in order to arrange customer needs and marketplace requirements with key business processes with the support of company's top leaders.

Hence, to meet the current and appearing requirements of customers, a "business process framework" configuration is provided at the end of work. Within the "business process framework" configuration, critical factors affecting the customer and marketplace requirements are identified. So, the Six Sigma projects are planned to satisfy key CCRs (Critical Customer Requirements) or CTQs (Critical To Quality's) that have been obtained from intensive research of customer or marketplace requirements (Sharma, 2003).

IV.1.1. Definition of Six Sigma

The name "Six Sigma" takes from statistical terminology, Sigma means standard deviation. The probability of falling within 6 sigma ranges around the mean of 0.9999966 for normal distribution. The "Six Sigma standard" means that the directivity rate of the process will be 3.4 defects per million units in a production process. Clearly, Six Sigma indicates a degree of extremely high consistency and extremely low variability. In statistical terms, the purpose of Six Sigma is to reduce variation to achieve very small standard deviations. Sigma ratings exist for processes, for example a process that produces 3.4 defects per million parts produced has a 6 Six Sigma rating. If the number of defects per million is higher at, for example 6,200 per million, the Sigma rating is only 4.

There were number of people in history who have contributed to today's definition of Six Sigma:

- 1) In the first half of the 1800s, Carl Frederick Gauss introduced the concept of a normal curve.
- 2) In the 1920s, Walter Shewhart proved that three sigma from the mean is the point where a process requires correction.

- 3) In the mid-1980s, Bill Smith, a Motorola engineer, explained that Six Sigma (which represents 3.4 defects per million) is the optimum level to balance quality and cost (Shah, 2003).

Additionally, there were some definitions and comments on Six Sigma and its dependent concepts in the literature;

"It's not an easy program, but here it's the real thing. We have transitioned from relying on anecdotal experience and intuition to a culture of data-driven decision-making."(Kline,1998)

"We eased people into the process. We asked, culturally, what could we stomach here? What could we apply and sustain? We simplified our approach and eliminated formal certification. We use the DMAIC model but most of our staff doesn't know it by that name."(Proudlove, 2002)

"The key to success is the commitment of leadership. Saying it and doing it are 2 separate things. It's when they put the funding in place that it really takes hold."(Ricondo, 2003)

"No, we are not a manufacturer, but of course we measure DPMO. A process is a process is a process"(Shah, 2003)

"It is not unusual to see an apparent drop in performance during early stages of Six Sigma programs once performance begins to be measured correctly" (Tannock, 2004).

"Six Sigma is a measure of customer satisfaction that is near perfection. Most companies are at the two or three sigma level of dissatisfaction occurrences per million customer contacts." (Eckes, 2001).

"...Six Sigma, unlike other quality initiatives that have come before it, is a management philosophy."(Eckes, 2001)

As marketing activities are situational, using systematic thinking for building inter-relationship of marketing components is very important. (Shah, 2003) mentioned that human behaviour is very situational.

"...Much of what we do is because of the situation we are in and who we are with." (Shah, 2003).

Sharma (2003) mentioned that a fundamental driving principle behind Instruction's Six Sigma efforts were to incorporate three stakeholders into outcomes of improvement. The three stakeholders were: employees, customers, and shareholders.

“...Looking at the organization’s three core processes :creating the products, acquiring customers and expanding relationship, and servicing and fulfilling customer requests.” (Sharma, 2003).

In addition to the definitions and comments, Six Sigma is especially a methodology that provides businesses with the tools to increase the capacity of the business processes. A process can be a product or a service process that a company provides to customers. Additionally, a process can be an interior process within the company, such as a production process. Six Sigma is a process improvement methodology that focuses on the customer. Like a number of other improvement methodologies, it involves understanding, measuring and improving performance in all areas that impact customer satisfaction. In Six Sigma, the aim of process improvement is to increase performance and reduce process variation. (Schroeder et al., 2008).

Eckes (2001) brought up that a process was defined as a series of steps and activities, which take inputs, provided by suppliers. And, these activities added value and provide outputs for their customers. Management needed to measure the existing sigma performance of each of their processes. This was especially crucial in marketing management, as there were number of marketing processes involved and they affect customers’ satisfaction either directly or indirectly. Hence, management not only identified the processes, but also monitored their performance. Their performance was supposed to add value in each process from suppliers to final outputs with a final destination of achieving their company’s business objectives.

There are numerous concepts related to Six Sigma:

- 1) Top management leadership,
- 2) Customer requirements,
- 3) Focus on financial and non-financial results,
- 4) Structured method of process improvement,
- 5) Strategic process selection
- 6) Full-time specialist.

IV.1.2. History of Six Sigma

Engineers at Motorola Corporation discovered in the 1980s the mathematically obtained point where the cost of eliminating a defect was greater than the cost of living with and repairing the defect. They discovered that; there was an acceptable

point of deficiency and any quality improvement made beyond that point would be more expensive than the expected cost savings of fixing the deficiency. These levels are illustrated in Figure IV.2.

Six Sigma is the fastest raising business management system in industry today. It has been credited with saving billions of dollars for companies since the early 1990s. Developed by Motorola in the mid 1980s, the methodology became well known only after Jack Welch from GE made it a central focus of his business strategy in 1995. (Mohr and Jackson, 2005).

Six Sigma was originally improved as a set of practices designed to develop manufacturing processes and eliminate defects. Nowadays, its application has been subsequently extended to other kinds of business processes as well. In Six Sigma, a defect is explained as anything that could cause customer displeasure.

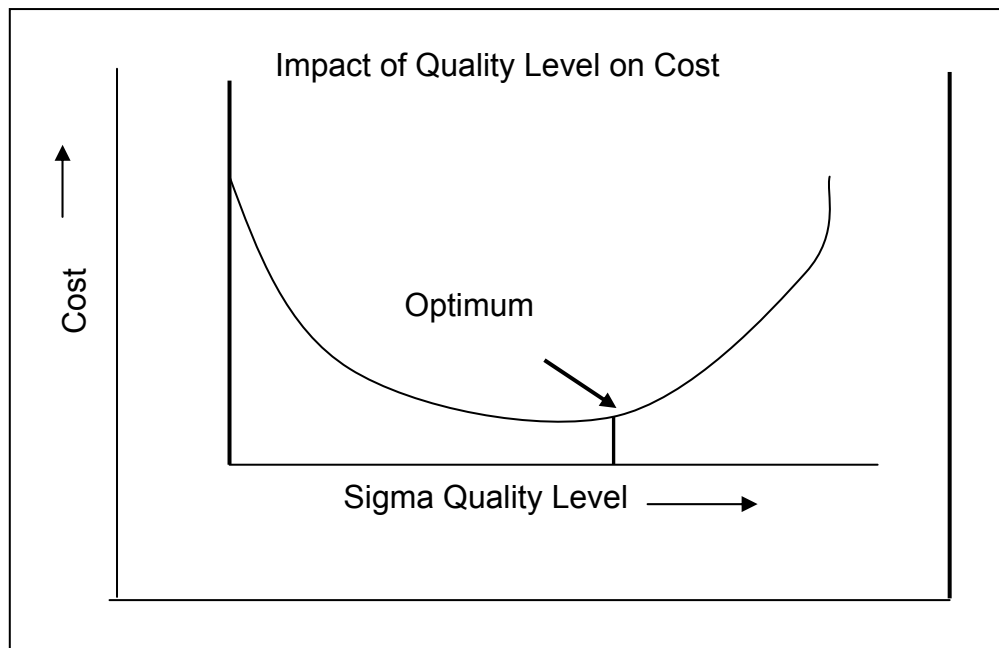


Figure IV.2 Impact of Quality Level on Cost (Kanji, 2003)

IV.1.3. Implementation Roles

One of the key innovations of Six Sigma was the professionalizing of quality management functions (Dittrich, 2006). Prior to Six Sigma, quality management in practice largely referred to the production facility and to statisticians in a separate quality department.

Quality improvement initiatives set apart Six Sigma from previous quality management features. Staff in organizations is specially trained to understand the

methodology and techniques involved in Six Sigma analysis.

IV.1.4. Six Sigma Levels

Short-term sigma levels correspond to the following long-term DPMO (Defects Per Million Opportunities) values (one-sided) taking the 1.5 sigma shift into account:

One Sigma = 690,000 DPMO = 31% efficiency

Two Sigma = 308,000 DPMO = 69.2% efficiency

Three Sigma = 66,800 DPMO = 93.32% efficiency

Four Sigma = 6,210 DPMO = 99.379% efficiency

Five Sigma = 230 DPMO = 99.977% efficiency

Six Sigma = 3.4 DPMO = 99.9997% efficiency

The widely accepted definition of a Six Sigma process is one that produces 3.4 DPMO. This is based on the fact that a process that is normally distributed will have 3.4 parts per million beyond a point which is 4.5 standard deviations above or below the mean (one-sided capability study). That's why the 3.4 DPMO of a "Six Sigma" process in fact corresponds to 4.5 sigma, namely 6 sigma minus the 1.5 sigma shift introduced to account for long-term variation. This is designed to avoid underestimation of the defect levels expected to be encountered in real-life operation (Banuelas, 2002). These rates are put into Table IV.1.

Table IV.1 Six Sigma Levels (Banuelas, 2002)

Six Sigma Levels	DPMO
6 σ	3.4
5 σ	233
4 σ	6210
3 σ	66807
2 σ	308537
1 σ	690000

The Six Sigma organization is built according to customer requirements. A Six Sigma project identifies a performance gap and goes through the DMAIC steps before attempting to achieve a decrease of variation.

IV.1.5 Methodology of Six Sigma

Six Sigma Methodology has two different processes;

DMAIC: A process that defines, measures, analyzes, improves and controls existing processes that fall below the Six Sigma specification. It is the basic methodology to improve existing processes.

Define: out of tolerance range.

Measure: key internal processes critical to quality.

Analyze: why defects occur.

Improve: the process to stay within tolerance.

Control: the process to stay within goals.

In this study DMAIC process was used in stead of DMADV. DMAIC is defined in figure IV.3

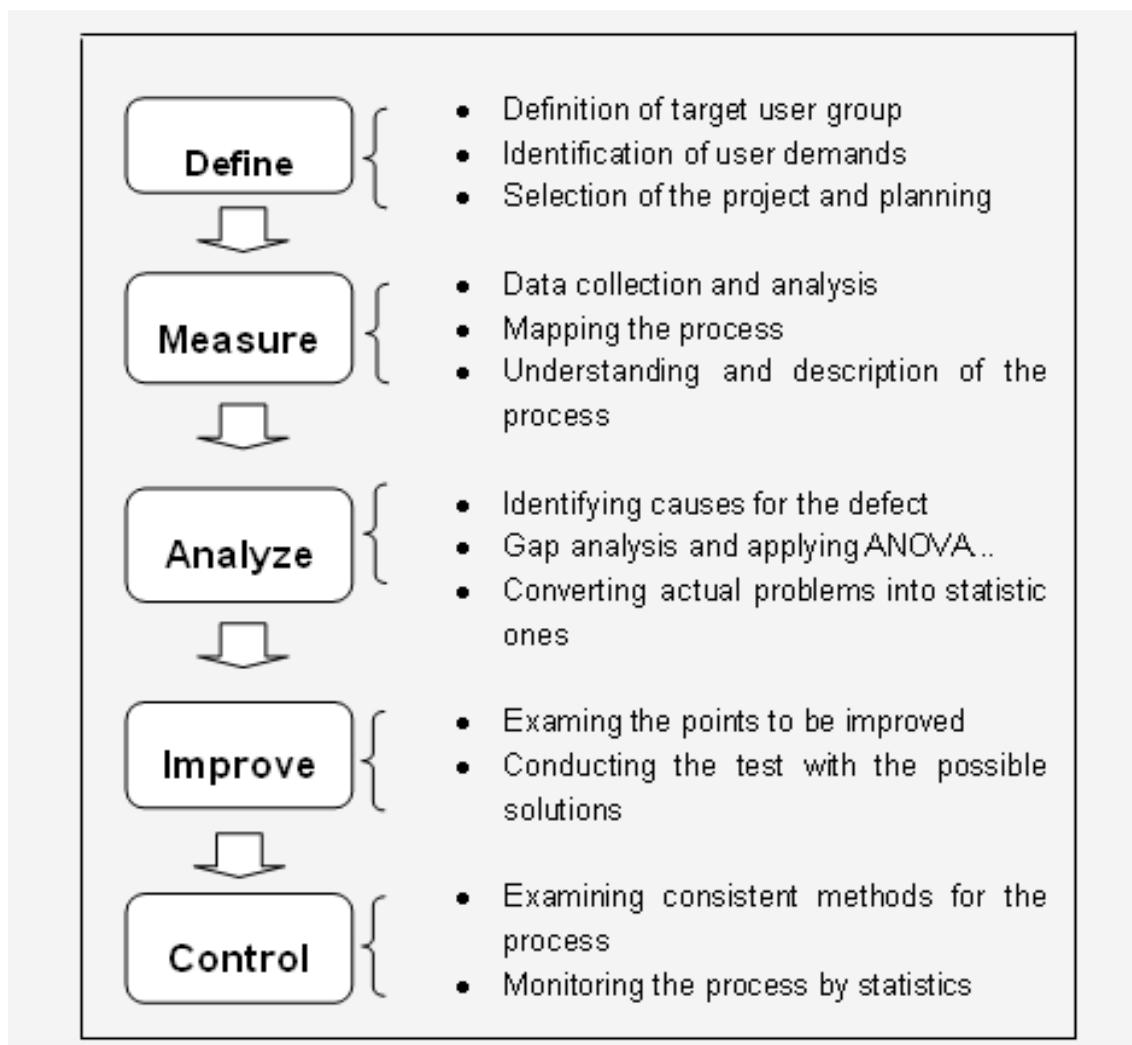


Figure IV.3 Five Steps of the Six Sigma (DMAIC)

DMADV: A process that defines, measures, analyzes, designs and verifies new processes or products that are trying to achieve Six Sigma quality. It is the basic methodology of introducing new processes.

Define: The process and where it would fail to meet customer needs.

Measure: Determine if process meets customer needs.

Analyze: The options to meet customer needs.

Design: In changes to the process to meet customers' needs.

Verify: The changes have met customer needs

DMADV Methodology wasn't used in this applied Study.

IV.1.6 Six Sigma DMAIC Process

Briefly, DMAIC means Define, Measure, Analyze, Improve and Control. Define Phase involves the definition of the assignment using application area, desired improvement, and benefits. Measure Phase involves the analysis of the process to determine its present state and the possible future state. In this phase, data collection is important. Analyze Phase involves the data analysis. Identification of parts of process, which affect the quality of the problem, is covered in this phase. DMAIC steps are listed in Table IV.2 with purpose, main activities and tools & techniques for each phase.

In Improve Phase, the best solutions are chosen and implementation plan is prepared. Then, the changes are materialized accordingly. In Control Phase, the changes are controlled and their effects are monitored. The basic DMAIC concept is defined in Figure IV.4 as a loop process for continuous improvement.

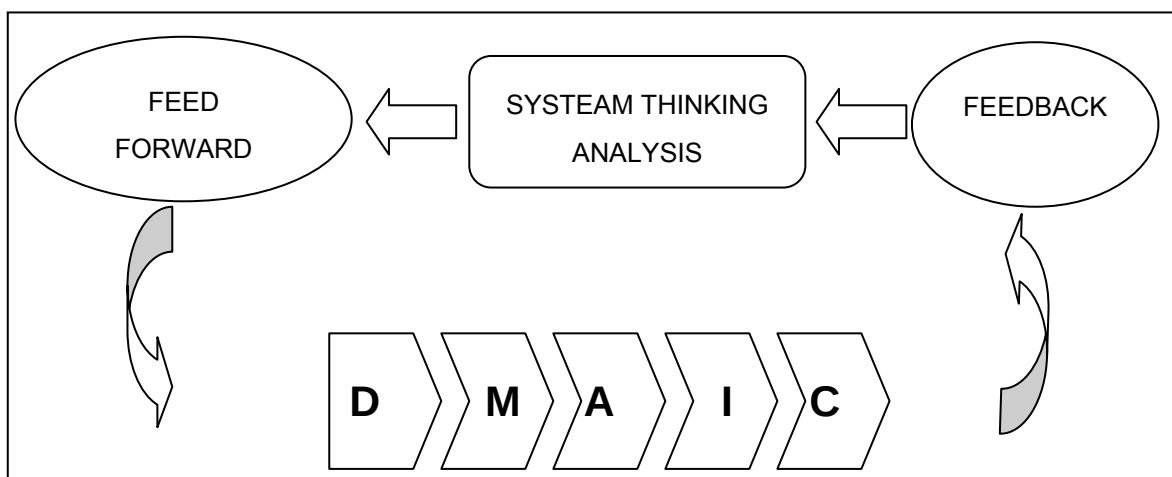


Figure IV.4 Systems Thinking Concept

Table IV.2 Six Sigma Steps Summary

(<http://www.heart.nhs.uk/18weeks/images/sixsigma/table1.gif>)

STEP	PURPOSE	MAIN ACTIVITIES	TOOLS & TECHNIQUES
DEFINE	Defines the problem, a clear mandate based on a real problem	-Identification of improvement opportunity - Development of charter -Listening to Voice of the Customer -Defining critical customer requirements - Mapping of processes	- Charter - Milestone Plan - Project Plan - Customer Surveys - Process Maps - Affinity Diagrams
MEASURE	To understand the baseline and current levels of performance	-Identification of measures -Development of operational definitions - Development & implementation of measurement plan - Collection of other baseline information	- Detailed Process Mapping - Measurement Plan (existing vs. new data)
ANALYZE	To establish problem root causes and understand their effect on process	-Identification of root causes -Validation of root causes -Determination of true causes of variation -Process control and capability -Analysis of detailed process maps for improvement opportunities -Data plotting & analysis -Determination the amount of variation within process -Determination sigma score	- Statistical process control -Process capability calculations -Defects per million opportunities - Fishbone diagrams - X&Y analysis - Cause and effect matrix - 5 whys - Pareto analysis - Hot spot matrix -Value/non-value added analysis - Histograms
IMPROVE	To develop, select and implement the best solutions	-Generating solution materials -Evaluation & selection of solutions -Development of process map for solution -Initiation of measure and evaluation of pilot -Communication of solutions to stakeholders & implementation of plan	- Process Maps - Brainstorming - Chain letter/ideas box - Affinity Diagrams - Force Field Analysis - Solution Screening - PDSA/Plot Studies
CONTROL	To ensure the solutions are embedded, that the process has robust controls	-Verification of reduction in variation and sigma score -Development of standard practices -Monitoring performance -Integration of lessons learned -Recommendation of future plans -Identification next steps and remaining opportunities	- Control plan/Dashboard - Procedures and Standards - Process Control Systems - Statistical Process Control -On going training and education

IV.1.7 DMAIC Process in Education Organization

The DMAIC Process is aimed for improving overall performance. By overall performance; attitude, team spirit, knowledge, result, and placement are meant. It should be lead by a principal. The committee is comprised of all departments' heads, technical and general staff. This will ease the preparation of the documents and the co-ordination of documentation. If required, students can be part of it; SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis can also be applied here. SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. Strengths and Weaknesses are internal factors. Opportunities and threats are external factors. (Yetiş et al., 2002).

IV.1.8 Six Sigma in the Educational Organization

The Six Sigma DMAIC is a process that defines, measures, analyzes, improves and controls existing processes that fall below the Six Sigma specification. An educational institution is a perfect place to demonstrate the application of Six Sigma. Figure IV.5. Demonstrates different modules of a typical education organization; these are the key elements of the organization.

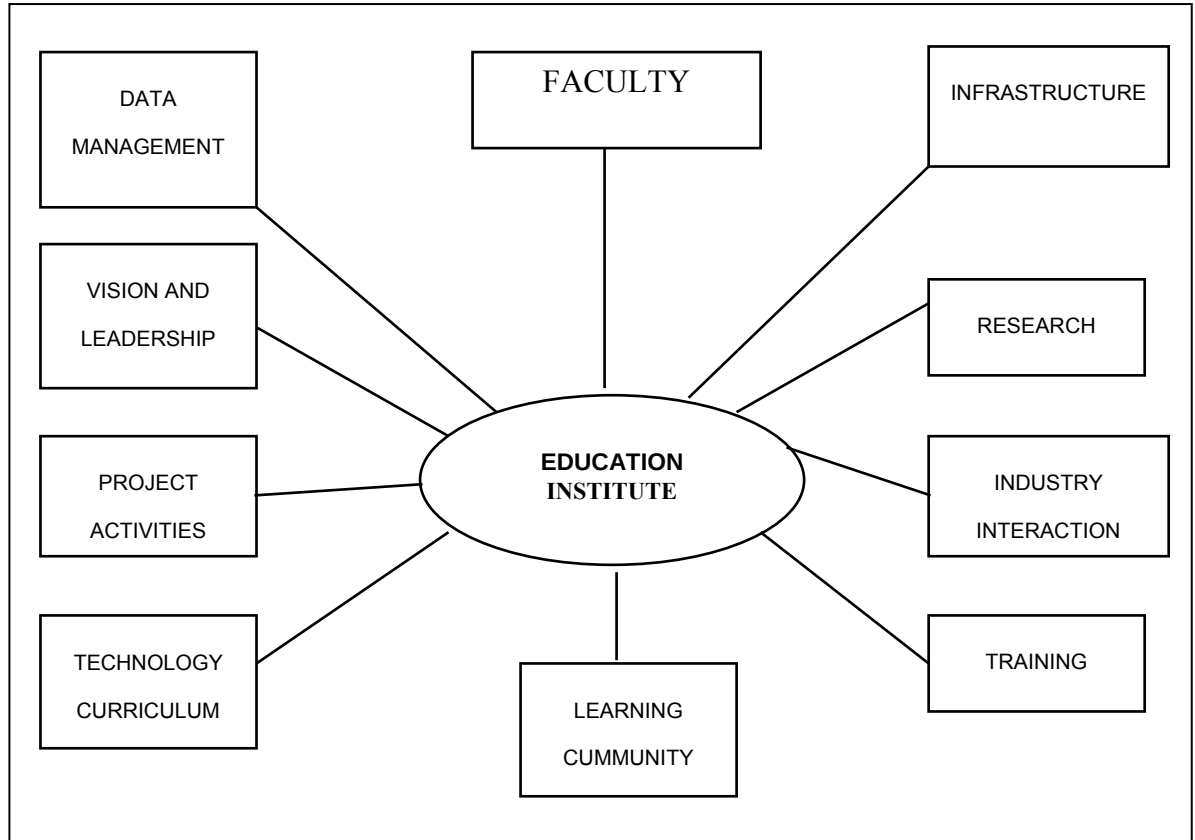


Figure IV.5 Education System Model (Hahn and Hill, 2007)

There are in all ten modules in the system according to Figure IV.5. These modules may have slight changes with respect to the system to which it is being applied (Hahn and Hill, 2007). More modules can be added or the existing modules can be split up in additional modules. Even though each module is addressed independently, there is an indirect inter-linkage among all of them.

The DMAIC process can be employed for an educational institution as well. The following sections will demonstrate how DMAIC works as well as how it can be implemented in education process.

IV.2. SIX SIGMA APPLIED STUDY IN THE FACULTY

The essential objectives of Six Sigma Methodology are to use data to show the differences in the average property value of product, to identify procedures to ultimately operate within six standard deviations of average performance and to reach customer requested measures.

The Six Sigma methodology intends to improve organization activities and projects related to the financial costs to the organization of poor quality. Generally, the cost of poor quality varies between 20% and 30%. The Six Sigma idea should also appear in the early stages of a process for the perfection of a process. These stages are listed in Figure IV.6.

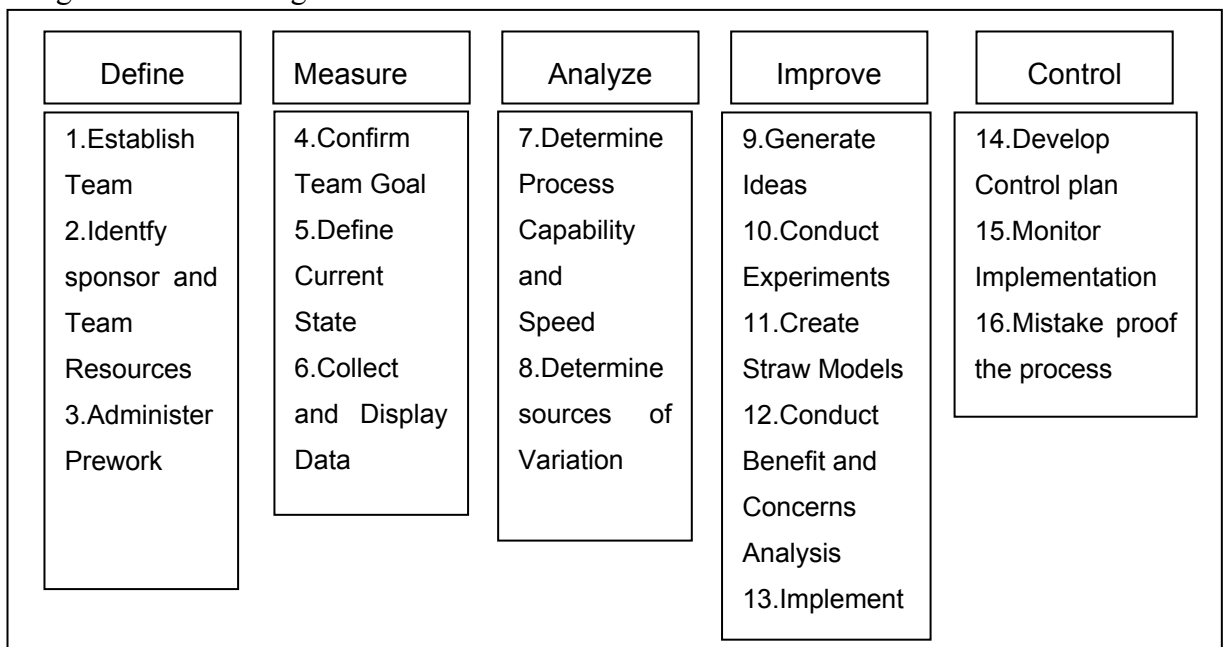


Figure IV.6 The DMAIC Methodology

(http://www.adamsixsigma.com/six_sigma_approach.htm)

In the Define Phase, the processes have been described by using Qualitative Analysis tools as initial phase of Six Sigma Methodology and the faculty's needs have been defined. In the Measure Phase, interviews were conducted with the IED of MU. In the Analyze Phase, the responses during the interviews were analyzed with the help of Qualitative Analysis tools. The most repeated processes were identified and solutions have been advised in the Improve Phase. Finally, Control Phase have been concerned with recommendations and suggestions for the IED of MU. Research Process Flow Chart for Applied Study is shown in the Figure IV.7.

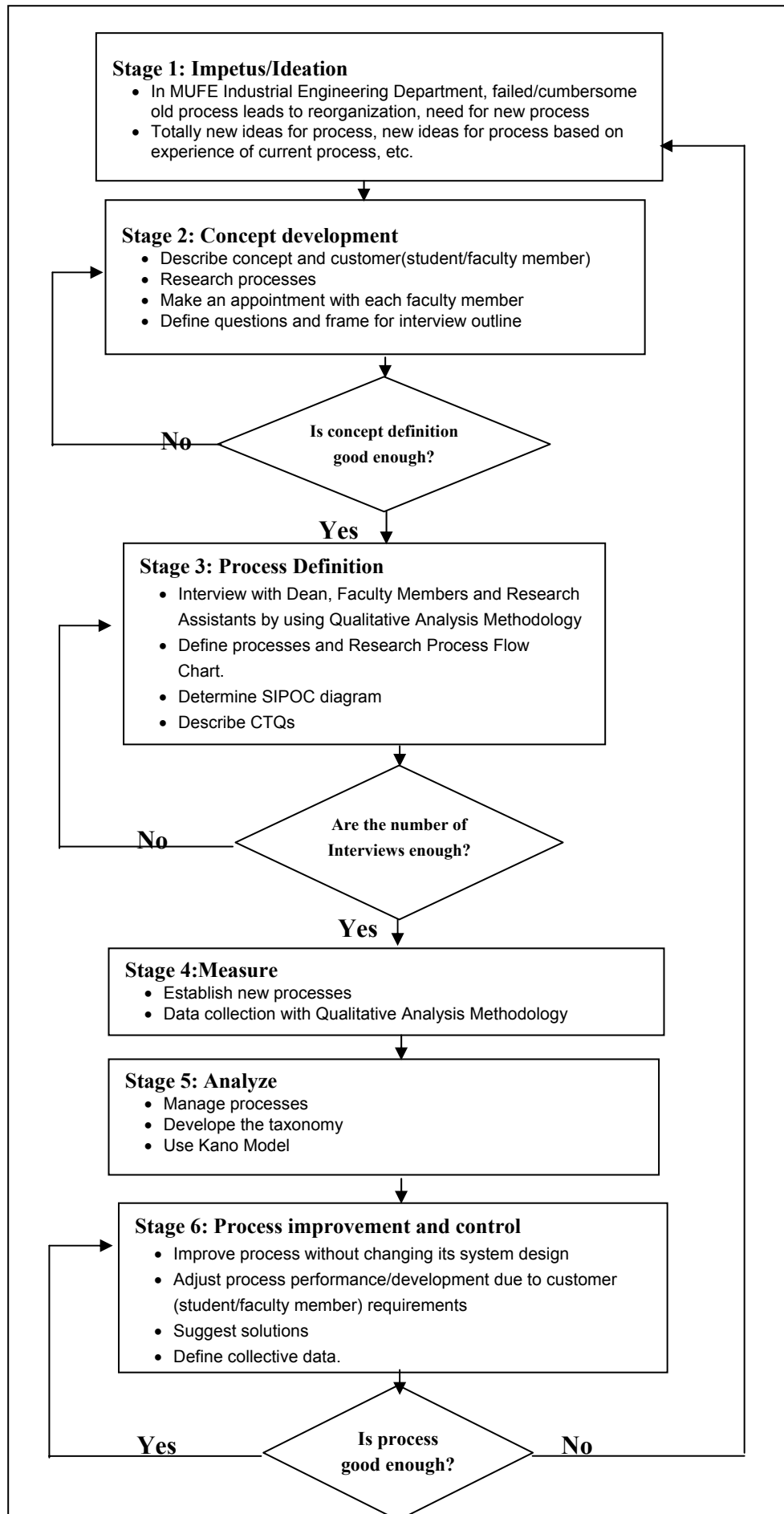


Figure IV.7 Process Flow Chart for Applied Study

IV.2.1. Define

The Six Sigma Methodology has been utilized as a basic tool for the evaluation and analyze of the Education Processes in the IED of MU. In the Define Phase, the processes have been described by using Qualitative Analysis tools as in the initial phase of the Six Sigma Methodology; the faculty requirements have also been defined.

During the Define Phase of a Six Sigma DMAIC project, the project leaders are responsible for clarifying the aim and scope of the project, for understanding the process to be improved, and for determining the customers' perceptions and expectations for quality. There is a check list to watch for when assessing a project's suitability for DMAIC:

- 1) Is data available or easy to obtain?
- 2) Does leadership support exist for improving this process?
- 3) Is DMAIC really needed or is this a "just do it": a problem with a known
- 4) Solution that should just be implemented?
- 5) Is the team trying to boil the ocean or is the scope reasonable for chartering as a DMAIC project?
- 6) Is the process directly related to a key outcome such as profitability, customer satisfaction, or employee satisfaction?

The key tool that assists with Define in this study was the Qualitative Analysis method. By using this method, the processes of the Education System of IED have been described. Once the process was understood, an insight into the causes of inefficiency and frustration would be gained so that improvements can be made. As the first step in the Define Phase, Research Process Flow Chart was described.

IV.2.1.1. Research Process Flow Chart

A process flow chart constitutes the outline in controlling the process progress. Depending on the type of process, a Six Sigma process flow chart may be created by using direct input from the individuals who participate in the process, by an observer who monitors and records information about the process, or a combination of the two. The most important aspect of this flow chart is to create a map of the existing process, good, bad or ugly. This is not the time to incorporate ideas for what can be done differently.

The start and stop points of the process under study should be determined as part of the Define phase, so the process mapping effort during the Measure Phase should have those same delimiters.

Typically an activity flowchart is used to create a visual depiction of the process. Individual steps are shown in order, with decision points and feedback loops as needed, to describe what occurs. Also another benefit for many processes is a deployment flowchart, which specifically illustrates who is performing each step. A flowchart can be used to highlight steps that are truly necessary and add value to the outcome, and to separate them from steps that represent waste and inefficiency.

In this study, Stage 1 of the Process Flow Chart has been denoted as Define Phase; additionally Stage 2 has covered Measure Phase as well. Analysis Phase has been applied Stages 3. Stage 4 has contained Improve Phase, also Control Phase has been described Stages 5. These stages are illustrated in Figure IV.8.

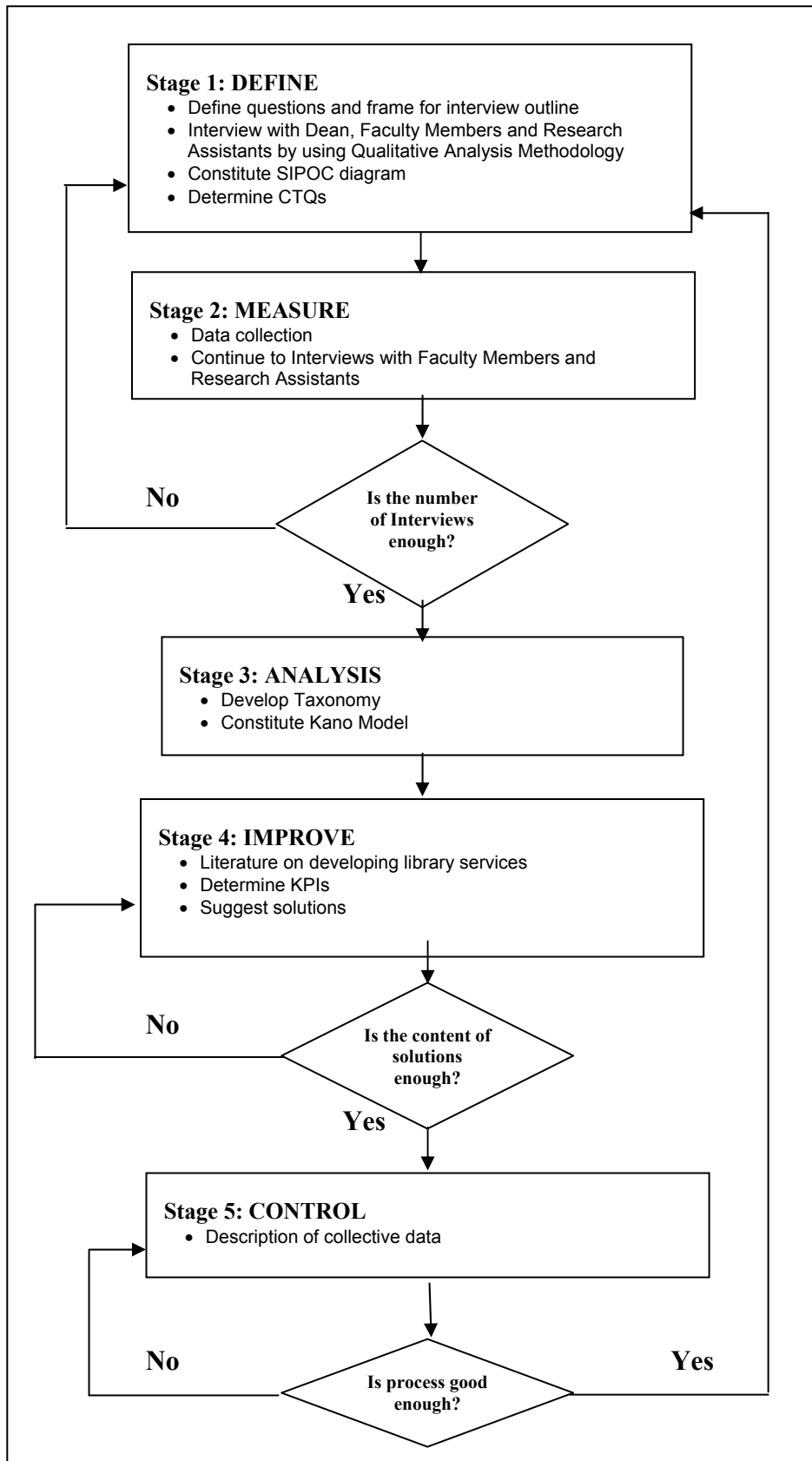


Figure IV.8 Research Process Flow Chart

IV.2.1.2. SIPOC (Suppliers, Input, Process, Outputs, Customers)

A SIPOC diagram is one of the most useful models for business and service processes. The aim of this phase is to make use of the idea “SIPOC (Suppliers, Inputs, Process, Outputs, Customers)” in Six Sigma to reduce defects by finding out the major components in marketing activities. It can also be used as a model for a manufacturing process. Six Sigma aims to improve the management of product, price, place, promotion and people with stakeholder concern with SIPOC diagrams with a target of meeting customers’ need, and with an ultimate goal of enhancing customer satisfaction. With the use of SIPOC in marketing metric, systematic and factual information can be consolidated for measuring performance of marketing promotion. The acronym SIPOC derives from the five elements in the diagram.

Supplier: The person or group that provides key information, materials, and/or other resources to the process

Input: The “thing” provided

Process: The set of steps that transform and, ideally, add value to the input

Output: The final product of the process

Customer: The person, group, or process that receives the output.

A generic SIPOC diagram is shown in Figure IV.9

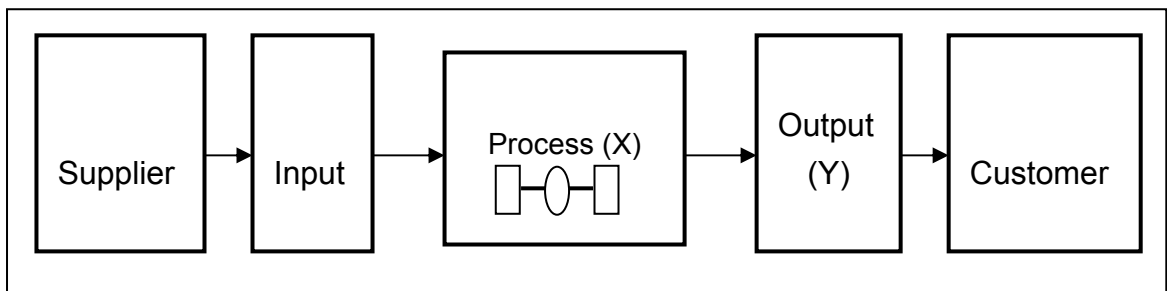


Figure IV.9 Generic SIPOC Diagram (<http://www.pacepilot.com/sipoc1.shtml>)

Customers usually have explicit or implicit requirements for the outputs, which are called customer requirements. These requirements are often listed in the SIPOC model as well. A clear definition of the boundaries of the process is crucial for success with a definition of the SIPOC. SIPOC plays a major role in developing a CTQ tree so as to identify quality requirements of the customer. SIPOC Models with definitions are listed in the Table IV.3

Table IV.3 SIPOC Model with Definitions

Suppliers	Inputs	Process	Outputs	Customers
Upstream providers of all of the inputs needed for the process under study to perform properly.	All of the inputs needed for the process under study to perform properly.	Macro (high level) description of the process being analyzed normally a maximum of 5-6 steps.	All of the outputs that are produced by the process being studied.	Downstream users of all of the outputs that are produced by the process being studied.

In the applied study, the education process of a University Department has been analyzed. The parts of SIPOC Diagram are explained in Figure IV.10;

Suppliers: Faculty members and administrators, support people and so on.

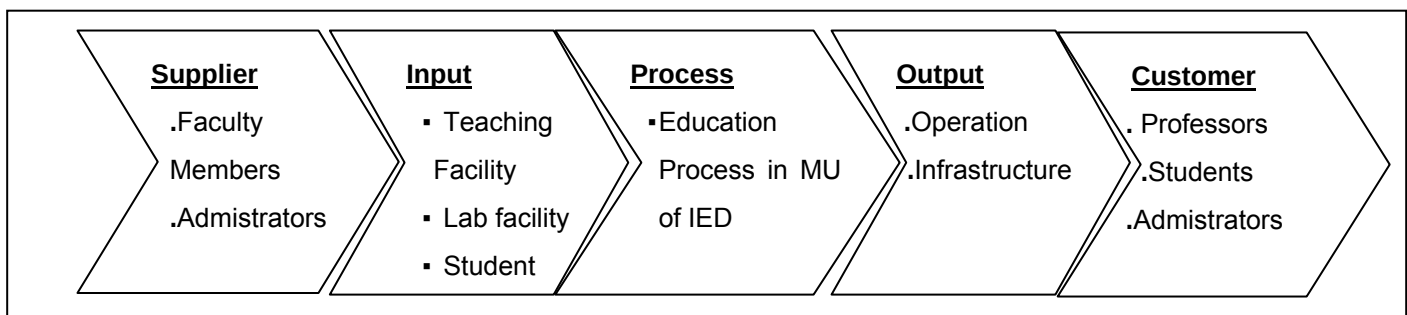
Inputs: Teaching faculty, laboratory facility and students.

Process: The Educational processes in the IED of MU.

Output: Operation and infrastructure.

Customers: Professors, students and administrators

Key requirements for output: Excellent combination of knowledge for a future career, high and consistent learning qualities, and other characteristics

**Figure IV.10** SIPOC Diagram of an Education Process

IV.2.1.3. Critical to Quality (CTQ) Tree

Critical-to-quality characteristics are the key measurable indicators of a product or process whose performance standards or specification limits must be met to satisfy the customer. In simple terms, CTQs are what customers expect of a

product or service. Irrespective of differences among services, there exist some common CTQs such as time, cost, employee behaviour, and information.

The CTQs were used in the second part of the Define Phase of the DMAIC Process. It was used to brainstorm and validate the needs and requirements of the customer of the process targeted for improvement. Important Education CTQs are listed in Table IV.4. ([http://books.google.com.tr/books/Critical to Quality tree Six Sigma For](http://books.google.com.tr/books/Critical%20to%20Quality%20tree%20Six%20Sigma%20For))

Table IV.4 Important Education CTQs

CTQs	➤ Time
	➤ Staff level
	➤ Cost of process
	➤ Volume of high quality output
	➤ Number of Academical Papers
	➤ Reputation of MUFE
	➤ Number of Faculty Members
	➤ Number of Research Assistants

The steps in creating a CTQ tree are as follows,

- 1) Identify the customer of the process targeted for improvement. A customer is the recipient of the product or service of the process.
- 2) Identify the need of the customer that is either the product or service desired by the customer.
- 3) Identify the first level of requirements of the need, that is, some characteristic of the need that determines whether the customer is satisfied with the need.
- 4) Drill down to more detailed levels of the requirement if necessary. Some requirements of the customer dictate greater specificity. If so, the tree will need to be created in greater detail.

Taxonomy in Table IV.6 shows that the CTQ tree is needed for evaluation and analyze of the educational processes in the Industrial Engineering Department of Marmara University. Here in the study, first level requirements of the need have been defined. Additionally, the second level requirements have been defined as well.

IV.2.1.4. Qualitative Research Approach to Problem Identification

In the Industrial Engineering Department, the recently enacted academic processes were assumed to require development; this requirement led to reorganization and/or the need for new processes.

For this reason, Dean, 7 Faculty Members of MUFE and 4 Research Assistants and 3 Library Staff were interviewed about recent academic processes and areas for improvement. Interviews were conducted with participants and staff about their experiences and perceptions. The purpose was to evaluate ideas for entirely new processes based on the experiences with the current processes. Records and documents were also examined. Then, the data from these interviews and observations were organized into major themes, categories and case examples through content analysis.

During the interviews, the Qualitative Research Case Study Method was used. Case Study Method was used to explore themes that emerged over time in diverse contexts. To facilitate rich descriptions and analysis, the data were analyzed using a Qualitative Analysis approach of constant comparative analysis (Miles and Hubermann, 2003).

By using a case method, faculty members' and research assistants' perceptions, concerns, and interpretations in the context of their interactions and cooperation with department chairperson have been examined; via this method, the processes have been defined. During the Qualitative Analysis of the processes, initial, detailed descriptions of process implementation were described and an analysis of major departmental processes was conducted.

Later, descriptions of different groups of participants, faculty members and research assistants, descriptions of how the department has affected participants and how the participants have affected departmental processes were outlined.

Finally, observed changes, outcomes, concerns, interpretations and impacts, analysis of the program strengths and weaknesses were denoted by participants. Interviews with faculty members and research assistants were outlined the Interview Framework.

At the end of interviews, the Interview Framework was evaluated and outlined in the following items:

- 1) Improvement of quality in education and training,
- 2) Improvement of education infrastructure,
- 3) Improvement of human resources and increased satisfaction,
- 4) Increased quality and quantity of science and art,
- 5) Improvement of physical infrastructure of institution,
- 6) Increased environmental cooperations and social service projects,
- 7) Increased financial resources,
- 8) Institutionalizing strategic plan process,
- 9) Improved reputation of the institution,
- 10) Increased quality and quantity of academical papers.

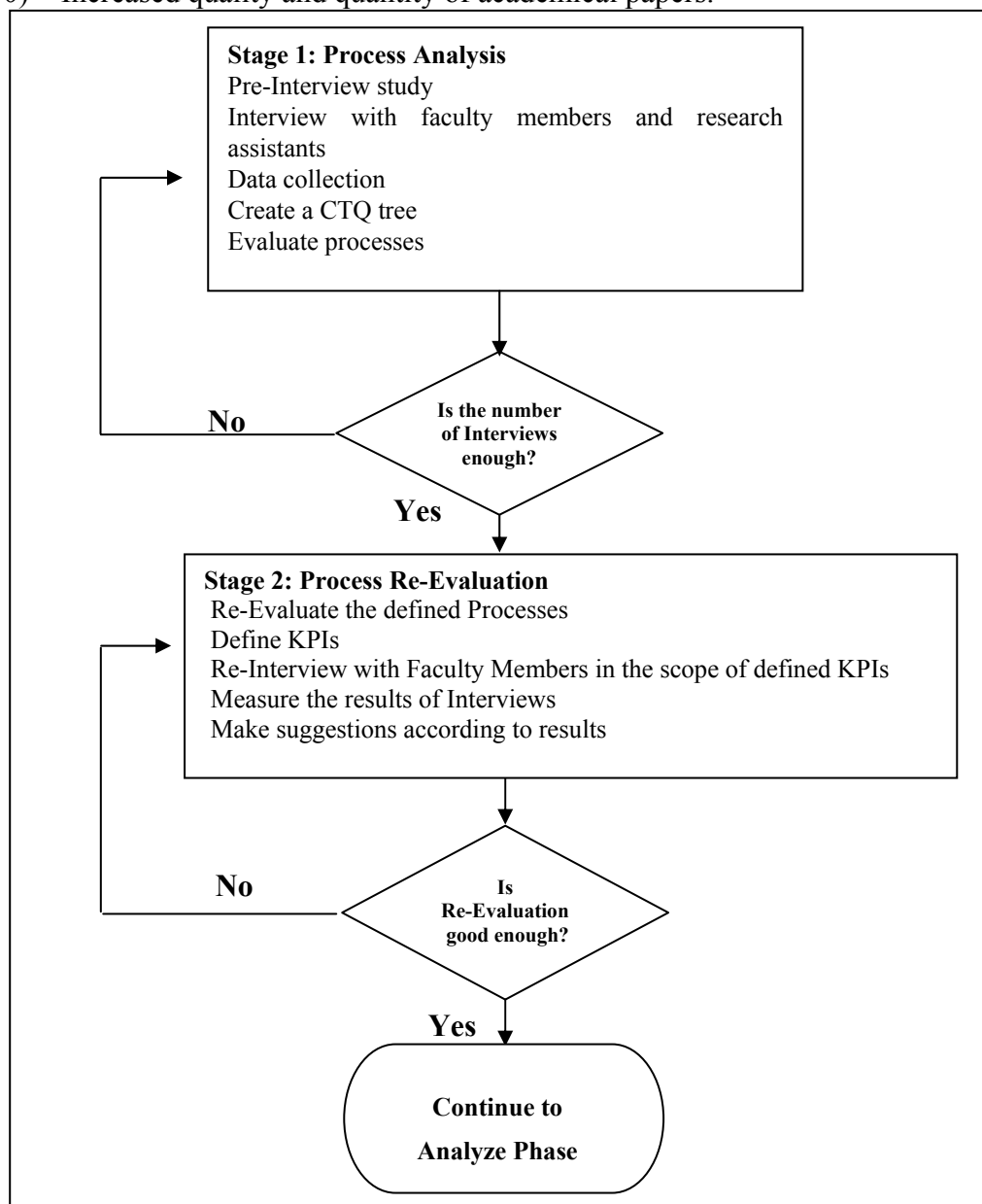


Figure IV.11 Qualitative Analysis Methodology Flow Chart.

The basic findings of Qualitative Research have been summarized in previous items and have been defined in the following Measure Phase of the Six Sigma Apply Study. Figure IV.11 is shown Qualitative Analysis Methodology Flow Chart.

IV.2.2. Measure

The academic processes were carried on to analyzed in the Measure Phase following a brief definition in the Define Phase.

In the second phase, the academic processes have been determined with all of the variables that impact the process inputs as well as the process outputs. Outputs of the processes were used to determine characteristics such as process capability, stability, reproducibility, and repeatability.

Obtaining as much information as possible about the current process required to fully understand both how the process works and how well the process works. The goal of the Measure Phase of a Six Sigma DMAIC project is to get the needed information. The Measure Phase entails creating a detailed process flow chart, gathering baseline data, summarizing and analyzing the data as key tasks.

Once the process flow chart is compiled, the observer shall review it to find out information about failed processes and problems. Evidence of missing steps, extra steps, delays, variations in how certain steps are performed, and other factors that may lead to defects, inefficiency and problems in process are required to be examined closely by the observer.

Measure is a logical follow-up to Define and is a bridge to the next phase, Analyze phase. The Measure Phase has two main objectives:

- 1) Gathering data to validate and to quantify the problem/opportunity occurring in the process. Usually, this is critical information to refine and complete the first process.
- 2) Beginning to find out the facts and numbers that offer clues about the causes of the problem.

In this study, the “Profile of Interviewed Faculty Members” section was created by using the Qualitative Analysis Methodology after the processes were defined in the Define Phase and the necessary data was collected.

IV.2.2.1. Data Collection

The Data Collection was performed by using the Qualitative Research. Interviews were performed with the faculty members of the Industrial Engineering Department of Marmara University. In total, Dean, 7 Faculty Members, 4 Research Assistants and 3 Library Staff provided information in detail about improvable areas in the Industrial Engineering Department. Interviews lasted between 30 minutes and 2.5 hours.

The major repeated findings were as follows:

- 1) Related to the background of faculty members,
- 2) Related to student selection criteria,
- 3) Related to buildings, classrooms and laboratories.

IV.2.2.2. Profile of Interviewed Faculty Members

In this study, interviews were conducted with Dean, 7 Faculty Members (4 Professors and 3 Assistant Professors), 4 Research Assistants and 3 Library Staff by using the Six Sigma Methodology and Qualitative Analysis Methodology. The following processes and problems were defined in order to improve the academic education processes of the MUFE. As a result of the interviews with faculty members, outputs were evaluated and then outlined in the taxonomy. Profile of the interviews is listed in Table IV.5.

Table IV.5 Profile of the Interviews

PROFILE	Faculty Members	Research Assistants	Library Staff
*Professor	5	-	-
Assistant Prof. Dr.	3	-	-
Ph.D Student (Research Assistant)	-	4	-
Employee	-	-	3
TOTAL	8	4	3

* Dean and 4 Faculty Members

IV.2.3. Analyze

In this step, the DMAIC searches into the details and enhances its understanding of the processes and problems. The DMAIC uses the Analyze step to find the “root cause.” Data are stratified in this phase and analyzed to determine the root causes of process problems. The goal of the DMAIC Analyze Phase is to identify potential root causes for the process problem being addressed and then confirm the actual root causes with data.

One of the principles of good DMAIC problem solving is to consider many types of causes. So, this situation does not allow biases or past experience affect the outcomes. After the completion of the Measure Phase, all information about processes should already have been gathered and data analyzed to establish the baseline performance of the processes.

The question that the Analyze phase seeks to answer is “Why is this problem occurring?” Another way to ask it is, “What is the cause of the problem?” It is not possible to make improvements to the process until the causal factors are identified. In many cases, clues to the factors affecting performance are already available based on the work that was performed in Define and Measure.

In the Analysis Phase, ‘Must-Be’ requirements, One-Dimensional requirements and Attractive requirements have been evaluated by using the Kano Model based on the results of the interviews in the Define and Measure Phases. These processes and problems were analyzed at the end of the interviews.

IV.2.3.1. Taxonomy Development

A Taxonomy including both CTQ and Education Theoretical Models were developed in the Analysis Phase after completing the Define and Measure Phases. The Taxonomy has enabled researcher to evaluate the Process and the purpose of this process.

However, the real purpose of developing the Taxonomy was to define the processes, which required to be improved as well as matching the results of the interviews with the faculty members and research assistants.

After Taxonomy Development, the processes were classified in Kano Model as ‘Must-Be’, One-Dimensional, and Attractive requirements. The developed Taxonomy, Processes/Problems, and Aims are explained in Table IV.6.

Table IV.6 The Taxonomy of Processes in Education

Processes/ Problems	AIMS
Improvement of quality in education and training	1. Composing, enhancing and updating of education and training programs. 2. Supporting of students' academical education. 3. Having programs in the IED of MUFE prepared for accreditation. 4. Improvement of living and working conditions of students and faculty members.
Improvement of Educational Infrastructure.	1. Development and restructuring of classrooms and laboratories. 2. Improvement of library and documentation infrastructure. 3. Enhancing and generalizing effective usage of university's information network. 4. Providing enough faculty member/student ratio. 5. Filling awaiting vacant posts of faculty members and research assistants.
Improvement of Human Resources and Increasing Satisfaction.	1. Increasing satisfaction of academic and administrative personnel. 2. Providing full time academical personnel. 3. Training qualified full time academical personnel. 4. Training and providing qualified technical and administrative personnel.
Increasing Quality and Quantity of Science and Art	1. Improvement effectiveness of research and application centers. 2. Increasing quality and number of research projects. 3. Increasing quality and number of international papers. 4. Increasing quality of international workshops managing by IED of MUFE. 5. Performing organizations like seminar, symposium and workshop at national and international level.
Improvements to the Physical Infrastructure of Institute.	1. Enhancing and renovating the institution. 2. Constructing new buildings or completing ongoing constructions concerning the institute's requirements.

Table IV.6 The Taxonomy of Processes in Education (Continued)

Increasing Environmental Cooperations and Social Service Projects.	1.Improvement of relations with national and international business environment and civilian public associations. 2.Increasing number of social service projects. 3.Providing the cooperation of the institute and industry.
Increasing Financial Resources.	1.Providing financial aid from the stakeholders of the university. 2.Increasing graduate education revenue. 3.Increasing rolling fund revenue. 4.Increasing revenue of foundations. 5.Starting social courses.
Institutionalizing Strategic Plan Process	1.Achieving continuity of strategic plan process. 2.Founding institutional performance evaluation system. 3.Improving application and service processes in the institute.
Increasing Reputation of the Institute.	1.Upgrading web sites of the institute. 2.Preparing advertisements and brochures for publicity of the institute. 3.Advertising the institute by media. 4.Increasing effectiveness of community of graduates and keeping in touch with the graduates.
Increasing quality and quantity of Academical Papers.	1.Accepting quality and quantity of academical papers as the major criterion for engaging and promoting of faculty members. 2.Encouraging preparing academical paper.
Developing of the Library Services	1.Short time frame for processing requests sent to technical services 2.Lack of verification of the claims submitted by vendors 3.Manual inputting and processing of the claims by vendors was laborious 4.While physically processing the items, there was some degree of work duplication in the receiving and cataloguing sections.

IV.2.3.2. Kano Model

The Kano Model of Customer (faculty member/student) satisfaction classifies product attributes based on how they are perceived by them and their effect on customer satisfaction. These classifications are useful for a guiding design decision in that they indicate when good is good enough, and when more is better.

Project activities in which the Kano Model is useful:

- 1) Identifying customer needs
- 2) Determining functional requirements
- 3) Concept development
- 4) Analyzing competitive products

Other tools which are useful in conjunction with the Kano Model:

- 1) Eliciting Customer Input
- 2) Prioritization Matrices
- 3) Quality Function Deployment

Value Analysis

The Kano Model of Customer satisfaction divides product attributes into three categories in Figure IV.12: “Must-Be” requirements, One-Dimensional requirements and Attractive requirements.

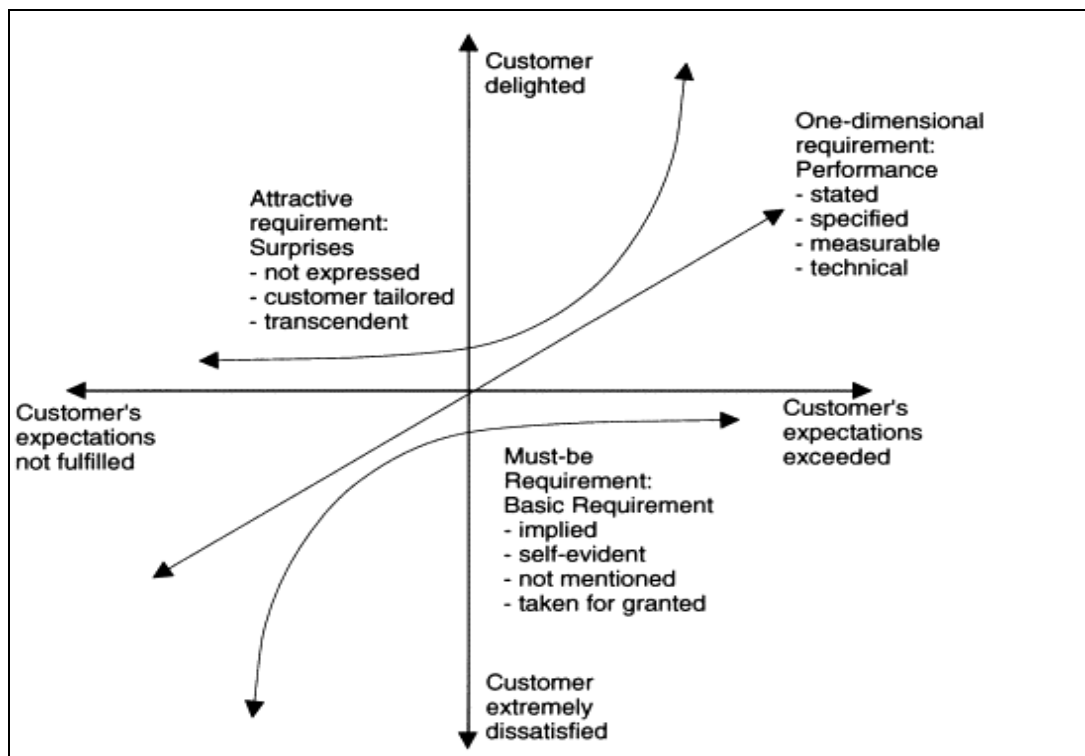


Figure IV.12 Kano Model (http://en.wikipedia.org/wiki/Kano_model)

Kano Model has been utilized in the analysis section of the Six Sigma Methodology Application.

‘Must-Be’ Requirements: The ‘must-be’ requirements are basic criteria of a product. If these requirements are not fulfilled, the faculty member and the student will be extremely dissatisfied. On the other hand, as the faculty member and the student take these requirements for granted, their fulfillment will not increase his satisfaction. Fulfilling the must-be requirements will only lead to a state of ‘not dissatisfied’. The faculty member and the student regard the must-be requirements as prerequisites; he takes them for granted and therefore does not explicitly demand them. Must-be requirements are in any case a decisive competitive factor, and if they are not fulfilled, the faculty member and the student will not be interested in the product at all.

Must-Be requirements of Kano Model are;

- 1) Increasing financial resources.
- 2) Development and restructuring of classrooms and laboratories.
- 3) Providing a sufficient faculty member student ratio.
- 4) Filling awaiting vacant posts of faculty members and research assistants.
- 5) Providing the cooperation of the Institute and Industry.
- 6) Improvement of the physical infrastructure of the institution.
- 7) Increasing reputation of the institute.
- 8) Developing the library services

Processes and problems have been analyzed at the end of interviews. It has been evaluated that a major problem has emerged from the financial resources requirement.

One-Dimensional Requirements: With regard to these requirements, faculty member and student satisfaction is proportional to the level of fulfillment. The higher the level of fulfillment is the higher the faculty member and the student’s satisfaction, and vice versa. One-dimensional requirements are usually explicitly demanded by the faculty members and the students. One dimensional requirements of the this study are;

- 1) Improvement effectiveness of Research and Application Centers.
- 2) Increased number of research projects.
- 3) Increased number of international papers.

- 4) Increased quality of international workshops managing by IED of MUFE.
- 5) Performing organizations such as seminar, symposium and workshop at both the national and the international level.

Attractive Requirements: These requirements are the product criteria, which have the greatest influence on how satisfied the faculty member and the student will be with a given product. Attractive requirements are neither explicitly expressed nor expected by the faculty member and the student. Fulfilling these requirements leads to more than proportional satisfaction. If they are not met, however, there is no feeling of dissatisfaction. Attractive Requirements of education process in this study are;

- 1) Upgrading web sites of the Institute.
- 2) Preparing advertisements and brochures for the publicity of the Institute.
- 3) Advertising the Institute via the media.
- 4) Increasing effectiveness of Community of Graduates and keeping in touch with the Graduates.

In this applied study, above classifications were evaluated at the end of interviews. While defining classifications, the processes which were the most emphasized by faculty members and which were considered fundamental in education life as “Must-be requirements”, the processes which could provide most additional contribution were classified as “Attractive requirements” and the remaining processes were classified as “One dimensional requirements”. “Developing the Library Services” process, which was classified as “Must-be requirement”, was considered applicable in short period easily. In the next Improve Phase, “Developing the Library Services” process was emphasized.

In Measure Phase, after collecting the data concerning the background of faculty members, student selection criteria and buildings, classrooms and laboratories were analyzed.

IV.2.4. Improve

Improve Phase is the latter of Measure Phase in DMAIC methodology. The goal of this step is to determine the appropriate solutions to implement using objective means, rather than making a decision based on assumptions or preferences. This is a common theme throughout the Six Sigma methodology. If the root causes of process performance problems are identified by process analysis, the solutions are

often featured by techniques such as process simplification and parallel processing.

At the end of second meetings with faculty members, following results have been obtained for the development and improvement of education processes in MUFE. The Important Education Processes are explained in Table IV.7.

In the Improve Phase, the above-mentioned solutions were evaluated. The purpose was to show that solutions could solve the problems and they could pioneer for improvement by using the data.

Additionally, a plan shall be created for the results in order to explain how they will be evaluated in the next phase. At this Phase, following tools are widely used.

- 1) Brain Storming
- 2) Data Collection
- 3) Experiment Design
- 4) Flow Charts
- 5) Failure Mode Effects analysis (FMEA),
- 6) Planning Tools (Tree Diagrams, Gantt Charts)
- 7) Hypothesis Tests

Table IV.7 Important Education Processes

Important Education Processes	➤ Improving the Quality of the Educations Programs
	➤ Improving Student Quality
	➤ Developing the Research Infrastructure
	➤ Increasing the Number and The Quality of the Scientific Publications
	➤ Increasing the Public and Private Sector Activities of Faculty Member
	➤ Reputation of MUFE
	➤ Making The Business Processes Related to Administrative and Academic Activities More Effective and Efficient
	➤ Improving The Services Provided to Students and Employees
	➤ Developing The Library Services

In the Improve Phase of this study, the processes can be improved by above-mentioned hypothesis tests and statistical analysis. In the next Control Phase, measurement and evaluation will be done for above-mentioned processes.

IV.2.4.1 Literature on Developing Library Services

There are a number of studies in the literature for developing of the Library Services.

First study was related to a survey, which was conducted at Charles Sturt University Library in 2008. The same survey was made for the University in August 2008, August 2006, October 2004, and September 2002. Survey was completed in three phases. The survey used a five-point scale for statistical analysis. This scale measured the results in terms of answers such as; “strongly disagree (1), disagree (2), indecisive (3), agree (4), strongly agree (5)”. For the study the survey questions are written in Table IV.8 (Hiller, 2008).

Table IV.8 Library Survey Questionnaires at Charles Sturt University

- | |
|---|
| <ul style="list-style-type: none"> ➤ Library staff treat me fairly and without discrimination ➤ Library staff display professionalism ➤ Library staff are friendly and helpful ➤ Library staff have the skills to deal with my query ➤ Library staff provide quality service ➤ Library staff are readily available to assist me ➤ Service staff respond in a timely manner ➤ Library staff provide clear and accurate answers/responses to my queries ➤ Requests for inter-campus loans are filled promptly ➤ Inter-library loan requests are filled promptly ➤ Books and journals are reserved quickly ➤ Library staff are proactive in their dealings with me ➤ Facilities are accessible to all on-site clients ➤ Individual seating is adequate ➤ Services for clients with disabilities are adequate ➤ Services for clients studying by Distance and/or Offshore are adequate ➤ Library staff describe clearly the services on offer ➤ Quiet study facilities are adequate |
|---|

Table IV.8 Library Survey Questionnaires at Charles Sturt University (Continued)

- Library web pages provide clear and useful information
- Library catalogue provides clear and useful information
- Photocopying & printing facilities are adequate
- The library collection is adequate for my needs
- The library web site is easy to use
- Facilities for using personal laptops are adequate
- The library catalogue is easy to use
- Prompt corrective action is taken regarding missing books and journals
- Opening hours meet my needs
- Library help guides are clear and useful
- Online help services are adequate
- Adequate signage exists within the library
- Group study facilities are adequate
- Wireless facilities are adequate
- Off-campus access to electronic information resources & services is adequate
- Access to electronic resources is easily available
- Library staff respond to my suggestions and ideas
- Access to computers to support study/research is adequate
- Course-specific resources are easy to find and access
- Electronic books and journals are easy to use
- Library staff keep me informed about new services, resources and collections

The first phase was the definition of “What is important for the library?” the second phase was the evaluation of performance of the library, and the final phase was definition of “Where clients believe the library can potentially improve?”

According to the survey results; the areas of highest importance to library clients included the ease of accessing electronic resources, ease of use of the library catalogue, the library website and electronic books and journals, staff being friendly, helpful, fair and non discriminatory and having the skills to deal with queries, adequacy of the collection, off-campus access to electronic information resources and services, the ease of finding and accessing course-specific resources.

But on the other hand, the following potential improvement opportunities have been determined;

- 1) Electronic books and journals are easy to use
- 2) Course-specific resources are easy to find and access
- 3) Access to electronic resources is easily available (Hiller, 2008).

Second study was related to strategic plans of The University of Illinois Library improvement, which was studied by Nitecki et al. in 2003. This strategic plan has been included in this study because of the goals and related action items for the reference study have been considered to be parallel with the goals of Marmara University Library.

According to the study, the University of Illinois Library would face a number of challenges such as; economic stresses caused by decreased funding and increased costs, changes in the composition and information-seeking behaviour of users, the effects of constantly evolving technologies, and changes in the scholarly publishing field.

The University of Illinois Library strategically planned expanding the service orientation, providing the users with world class connections and resources, building the infrastructure for the 21st century, developing resources and partnership for the 21st century.

Strategic plan included goals and related action items for every goal. The goals were defined as;

Expanding The Service Orientation

Goal I.A. Assessing Service Quality

The University Library shall assess the quality of services, build upon our strengths, and strategically address areas of user frustration.

Goal I.B. Improving Service Skills

The University Library shall provide ongoing, comprehensive training and develop clearly articulated expectations to ensure that all personnel possess the skills requisite for their positions and demonstrate a strong service ethic.

Goal I.C. Developing New and Innovative Services

The University Library shall ensure continuous improvement of service quality through the aggressive testing, adoption, and integration of new practices and technologies that better serve the needs of our diverse clientele.

Goal I.D. Developing and Promoting User Instruction

The University Library shall develop, implement, and promote a comprehensive information literacy program that reaches our constituencies through teaching and outreach.

Goal I.E. Engaging the Public

The University Library shall develop and implement an outreach plan that engages our public through proactive programming and promotional initiatives that provide greater visibility to the Library's collections and services both on and off campus (Nitecki et al., 2003).

Providing the Users with World-Class Collections and Resources

Goal II.A. Supporting the University's Educational Priorities and Research Needs.

The University Library shall acquire both commonly-held core materials and those that build unique collections in order to better support the University's mission as a land-grant institution, a leader in global affairs, and a repository of cultural artifacts with an increasing focus on interdisciplinary study.

Goal II.B. Meeting Identified and Emerging Access Needs

The University Library shall improve access by providing broader, more effective access to its collections and information resources in all formats.

Goal II.C. Preserving Our Assets for the Future

The University Library shall support the further development of its preservation and conservation program, supporting the University's scholarly priorities, and promoting the retention of collections in a manner consistent with the Library's mission as a public research institution and a collection of record.

Goal II.D. Developing Digital Content

The University Library shall identify priorities and implement programs for the development and preservation of digital content that supports user needs.

Goal II.E. Supporting Changing Modes of Scholarly Communication

The University Library shall support the reconceptualization of current modes of scholarly communication with the goal of controlling unsustainable costs and facilitating broader availability of scholarly output (Nitecki, 2005).

Building an Infrastructure for the 21st Century

Goal III.A. Promoting a Progressive Institutional Culture

The University Library shall review its current administrative and organizational practices; implement new strategies that encourage the development of a progressive, positive culture; support the institution's efforts at providing excellent services and collections to its users and personnel; and encourage innovative practices.

Goal III.B. Reexamining Collections and Service Points to Provide Better Service

The University Library shall reevaluate the physical organization of collections and service points throughout the Library system with the purpose of improving efficiencies, rethinking existing operational models, supporting the ongoing development of its high-density storage facility, and better serving our diverse clientele.

Goal III.C. Improving Facilities for The Collections, Users, and Personnel

The University Library shall complete existing projects, begin projects necessary to improve the physical environment in existing library spaces, and develop priorities and plans for new facilities that meet its service and stewardship goals.

Goal III.D. Maintaining The Information Technology Infrastructure

The University Library shall support its mission by continually assessing the ability of its Information Technology (IT) infrastructure to meet the Library's needs and by providing effective IT services and the infrastructure required to support emerging Library services (Dunaway, 2003).

Developing Resources and Partnerships for the 21 st Century

Goal IV.A. Generating Resources to Support Our Growing Needs

The University Library shall actively develop non-traditional strategies to offset losses experienced through changes in the funding of higher education. The pursuit of development activities, grants, and other alternate and entrepreneurial means of funding new and on-going activities shall be the responsibility of all members of the Library community.

Goal IV.B. Implementing a Comprehensive Development Plan

The University Library shall build upon the successes of the current Campus Campaign for the Library in order to better meet the needs of our users through

excellent, well maintained collections; facilities that are conducive to learning, research, contemplation, and socialization; and the personnel necessary to provide high quality services.

Goal IV.C. Promoting Partnerships and Leadership Roles that Support The Mission.

The University Library shall establish partnerships not only across campus, but also with local, regional, national, and international organizations in order to enrich our current services, collections, and programming activities and to assume leadership roles that enhance the Library's role in the state, nation, and world. ([Http://www.Library.Uiuc.Edu/Committee/Strategicplanning/Reports/Jan00report.Html](http://www.Library.Uiuc.Edu/Committee/Strategicplanning/Reports/Jan00report.Html)).

Third study was related to the processes for continuous improvement for the University Library, which was studied by Terrell (2002) at Sonoma State University. These processes were defined as Trend Analysis, Technology Development, Collaboration, Staff Support, Use of Space, Marketing, Assessment, and Funding. The contributors of continuous improvement were as follows;

Trend Analysis

The University Library shall acknowledge the necessity for routine analysis of current and emerging trends that may impact its role in student learning.

Technology Development

The University Library shall recognize that information technology, learning, and teaching are inextricably tied together. The Library shall continue to provide the technology platforms necessary for accessing and creating information in digital, multimedia, and print formats and for experimenting and innovating using new technologies that support learning goals.

Collaboration

The University Library believes that cross-campus efforts are the most effective means for supporting student learning and using resources efficiently. With this view, all planning efforts shall endeavor to identify and include strategic partners on campus that can help bring our action initiatives to fruition.

Staff Support

The University Library shall be committed to developing a vibrant, flexible, and skilled workforce with a desire for continuous improvement, a focus on student learning success, and excellent service standards.

Use of Space

All planning efforts shall recognize that the University Library must provide stewardship of a public facility intended to serve a growing student population and to respond to continual change in the information environment.

Marketing

The planning initiatives are vital to the University Library's role in the educational enterprise, and each action initiative with an appropriate marketing plan that ensures that our programs and services reach target audiences shall be supported.

Assessment

Understanding that every effort of the University must be measured for effectiveness and impact on student learning, the University Library shall establish assessment methods for programs and services (Terrell, 2002).

Funding

Sustaining service and technology initiatives and designing innovative programs rests on close analysis and management of funding resources. Planning priorities may indicate the need to augment the general fund allocation for program enhancement. The University Library must be prepared to seek additional financial resources through external fund-raising, grant procurement, and collaborative partnerships.(<http://www.Library.Uiuc.Edu/Committee/Strategicplanning/Reports/Jan00report.Html>)

The forth study was about required initiatives for continuous improvement of the library. According to Schulz in 2005, there were six different initiatives identified for continuous improvement in terms of "Library as Place", "Teaching", "Information and Access", "Technology", "Marketing", "Fund Raising". These initiatives were outlined along with goals and specified action items as follows;

Initiative One: Library as Place

The University Library shall embrace its role as a dynamic space for intellectual, cultural, and social interactions that enrich student life.

Goal 1: Ensure an active learning environment to support a variety of student learning styles. This goals are explained Table IV.9.

Table IV.9 Goals-1 about Library as Place

GOAL-1:	➤ Design innovative digital learning spaces
	➤ Designate teaching and learning spaces for an expanding library instruction program
	➤ Provide student work spaces for collaborative Work
	➤ Provide sufficient space for quiet study and Research

Goal 2: Provide a venue for enrichment of student life and campus culture. This goals are explained Table IV.10.

Table IV.10 Goals-2 about Library as Place

GOAL-2:	➤ Explore joint programming opportunities with The campus residential community
	➤ Partner in a variety of co-curricular campus Activities
	➤ Design dynamic art exhibitions and lecture programs to support the liberal arts & sciences mission
	➤ Provide an intellectual and social commons where students feel comfortable and welcome

Goal 3: Review allocation of the library's physical space to meet evolving learning needs and campus directions. This goals are explained Table IV.11.

Table IV.11 Goals-3 about Library as Place

GOAL-3:	➤ Ensure visible and efficient services through regular review of service policies and staffing models
	➤ Solicit user feedback to inform decisions about optimal allocation of public space
	➤ Evaluate internal workspace design to optimize The library's role in student learning
	➤ Ensure adequate physical capacity for information resources in different formats
	➤ Analyze space allocation holistically in response to changing campus needs

Goal 4: Enhance stewardship of the facility. This goals are explained Table IV.12.

Table IV.12 Goals-4 about Library as Place

GOAL-4:	➤ Audit building safety and improve security Processes
	➤ Seek physical improvements to secure the integrity of the library as place
	➤ Evaluate accessibility needs on a regular basis
	➤ Monitor maintenance and upkeep

Initiative Two: Teaching

In partnership with campus-wide instructional efforts, the University Library shall prepare students to be lifelong learners.

Goal 1: Enhance learning through a comprehensive information competence program to meet the planning initiatives of Academic Affairs. This goals are explained Table IV.13.

Table IV.13 Goals-1 about Teaching

GOAL-1	➤ Expand the current first-year information literacy program
	➤ Articulate a cohesive approach for information literacy instruction in the disciplines
	➤ Improve assessment methods for the library instruction program as a whole
	➤ Incorporate sustainability in planning for the information literacy program

Goal 2: Leverage academic technologies to support the information competence program. This goals are explained Table IV.14.

Table IV.14 Goals-2 about Teaching

GOAL-2	➤ Evaluate technological approaches to information competence instruction for best practices
	➤ Actively solicit student and instructor feedback on effective online teaching modules
	➤ Develop a plan to create high-quality digital learning objects to enhance teaching and learning goals
	➤ Explore the integration of information competence modules with campus learning management systems

Goal 3: Expand the information literacy program through partnerships with discipline faculty. This goals are explained Table IV.15.

Table IV.15 Goals-3 about Teaching

GOAL-3	➤ Improve orientation and training in information competence for new faculty
	➤ Develop information competence modules for faculty to adopt
	➤ Develop training in information competence pedagogy in various formats
	➤ Assess the program to encourage continuous faculty engagement

Initiative Three: Information and Access

The University Library shall judiciously expand curriculum-based collections and accelerate the transition to digital access.

Goal 1:Expand compelling collections of digital, multimedia, and print resources to support academic goals and campus programs. This goals are explained Table IV.16.

Table IV.16 Goals-1 about Information and Access

GOAL-1	➤ Collaborate closely with instructional faculty to ensure the procurement of on-target resources
	➤ Build co-curricular collections to support the growing campus residential community
	➤ Support the National University Libraries' cooperative collection development efforts to reduce redundancy and costs
	➤ Boost resource sharing by expanding interlibrary services to meet student and faculty needs

Goal 2: Streamline digital and physical access to all resources. This goals are explained Table IV.17.

Table IV.17 Goals-2 about Information and Access

GOAL-2	➤ Migrate to digital formats where appropriate
	➤ Actively improve pathways to digital resources
	➤ Anticipate changing patterns in student learning when selecting information access alternatives
	➤ Ensure compliance with disabled accessibility guidelines

Goal 3: Digitize unique collections to heighten learning and resource sharing. This goals are explained Table IV.18.

Table IV.18 Goals-3 about Information and Access

GOAL-3	➤ Explore options for a campus digital institutional repository
	➤ Identify unique library collections for digitization projects

Goal 4: Construct a funding model to support digital access to library collections. This goals are explained Table IV.19.

Table IV.19 Goals-4 about Information and Access

GOAL-4	➤ Analyze and project the implications of campus growth and funding patterns on collection development and management
	➤ Review the information resources budget at regular intervals to keep access stable

Initiative Four: Technology

The University Library shall commit to an evolving technology environment that facilitates teaching and learning.

Goal 1: Identify and integrate appropriate new technologies to support academic achievement. This goals are explained Table IV.20.

Table IV.20 Goals-1 about Technology

GOAL-1	➤ Monitor information technology trends for innovative library applications
	➤ Leverage current library technologies as effectively as possible
	➤ Investigate integration of library resources with academic technologies such as learning management systems
	➤ Analyze user patterns to anticipate student learning needs
	➤ Analyze and implement technology applications recommended for the CSU libraries consortium

Goal 2: Partner with other campus groups to advance academic technology support. This goals are explained Table IV.21.

Table IV.21 Goals-2 about Technology

GOAL-2	➤ Consider establishing an instructional technology council with members from the Library, the Center for Teaching and Professional Development, and other relevant groups
	➤ Participate with partners in annual planning for joint delivery of academic technology services
	➤ Seek collaborative opportunities for offering instructional technology training

Goal 3: Seek greater efficiencies in Library public computing to support student learning needs. This goals are explained Table IV.22.

Table IV.22 Goals-3 about Technology

GOAL-3	➤ Assess public computer configuration, including output options such as printing
	➤ Standardize software with campus labs as appropriate
	➤ Review placement of computers in public areas on a regular basis

Goal 4: Improve support services for public and internal computing in the Library. This goals are explained Table IV.23.

Table IV.23 Goals-4 about Technology

GOAL-4	➤ Establish user feedback and assessment methods
	➤ Improve support services to ensure employee Productivity
	➤ Establish performance guidelines for members of the library technology support team

Initiative Five: Marketing

The University Library shall aggressively promote its services and resources.

Goal 1: Ensure continuous improvement of services based on user needs and feedback. This goals are explained Table IV.24.

Table IV.24 Goals-1 about Marketing

GOAL-1	➤ Conduct internal assessments to ensure that the library adopts a user-centered approach in all practices
	➤ Develop online surveys for feedback on specific services and resources
	➤ Establish focus groups for feedback on services and resources

Goal 2: Upgrade current marketing and public awareness programs for effectiveness. This goals are explained Table IV.25.

Table IV.25 Goals-2 about Marketing

GOAL-2	➤ Revise the marketing and public relations plan
	➤ Model best practices in marketing
	➤ Secure staffing support for programs and practices

Goal 3: Use innovative approaches to reach audiences. This goals are explained Table IV.26.

Table IV.26 Goals-3 about Marketing

GOAL-3	➤ Develop a program for streamlined information dissemination
	➤ Maximize the website as a creative marketing tool
	➤ Continue to strengthen relationships with campus constituencies

Goal 4: Create new promotional materials to support Library initiatives. This goals are explained Table IV.27.

Table IV.27 Goals-4 about Marketing

GOAL-4	➤ Refresh graphic design templates
	➤ Establish a systematic plan for creating promotional materials
	➤ Review marketing materials for improvement on a regular basis

Initiative Six: Fund Raising

The University Library shall explore sources of supplemental funding for continuous improvement of services and programs. This goals are explained Table IV.28.

Goal 1: Plan development activities to support the University Library

Table IV.28 Goals-1 about Fund Raising

GOAL-1	➤ Create an internal steering group to analyze advancement needs
	➤ Draft a development plan
	➤ Set working time lines for a three-year period

Goal 2: Implement stand-alone giving programs to support Library initiatives. This goals are explained Table IV.29.

Table IV.29 Goals-2 about Fund Raising

GOAL-2	➤ Create giving opportunities such as buy-a-book or build-a-subject programs
	➤ Develop promotional print and online materials detailing giving options
	➤ Explore the use of online tools for direct giving
	➤ Identify ways to improve library donor Stewardship

Goal 3: Investigate new fund-raising approaches. This goals are explained Table IV.30.

Table IV.30 Goals-3 about Fund Raising

GOAL-3	➤ Seek campus partnerships for collaborative fund-raising and friend-raising activities
	➤ Host promotional events to showcase library resources and cultivate supporters
	➤ Explore collaborations with community organizations
	➤ Explore grant opportunities for project support

Goal 4: Analyze and improve the role of support groups for optimal public relations (Schulz, 2005). This goals are explained Table IV.31.

Table IV.31 Goals-4 about Fund Raising

GOAL-4	➤ Review the Friends of the Library organization, including basic mission, operating challenges, and new roles
	➤ Explore online book-selling options
	➤ Analyze docent and volunteer activities

The fifth study was about the review of The Library of University College Dublin, which was studied by Monaghan (2003). In The Library of University College Dublin has been reviewed by a group of professionals.

Recommendations have been considered beneficial for improvement of the library. Recommendations were given in terms of organization & structure, infrastructure and technology support, space and facilities, services provided by the library and information resources (Monaghan, 2003). The basic recommendations for the improvement of the library have been listed as follows:

Organization & Structure:

The structure of the library shall focus clearly on users. These structures are shown Table IV.32. This structure must enable the Library to exploit its resources to ensure that:

Table IV.32 Organization and Structure

Organization and Structure	➤ Library services are efficient, flexible and able to respond promptly and effectively to users' needs
	➤ The Library plays a key role in the academic team charged with delivering the University's learning, teaching and research
	➤ Expand the management role of senior posts
	➤ Provide clear reporting lines
	➤ Concentrate resources to provide highest possible service to users
	➤ Enable professional Library staff to manage teams to deliver services
	➤ Encourage the professional Library staff to build constructive relationships with users
	➤ Facilitate the development of the hybrid Library for the University
	➤ Be receptive to changing needs of users e.g. new curriculum, new ways of learning and teaching, collaborating with other institutions
	➤ Allow complex procedures in all areas to be reviewed and simplified
	➤ Allow for flexible responses to changing demands
	➤ Foster a team-based approach
	➤ Encourage innovation
	➤ Ensure that the library Systems infrastructure supports all library operations

Above all the new structure should empower all library staff to adopt a user focused approach (Bodie, 2001).

Infrastructure and Technology Support:

The provision of a University-wide reliable network infrastructure is critical to Library services and should be raised urgently with the appropriate University funding bodies.

The Library and computing services should investigate the identified technology issues and make specific recommendations for improvement.

The move to electronic materials should be accelerated, in line with the stated preference of users.

The library should develop a systematic, consultative and consistent approach to information systems and technology training for its staff. The training programmer must be, and be seen to designed to support stated library objectives and linked to the Library's Strategic Plan (Nimsomboon, 2003).

Space and Facilities

The entrance to the Library should reflect its central role in the life of the University. The strategic planning process shall identify accommodation needs (including new buildings and refurbishment) and the likely costs. This facilities and spaces are shown Table IV.33.

Table IV.33 Space and Facilities

Space and Facilities	➤ Development of strategic alliances with other libraries concerning storage space.
	➤ An overall refurbishment plan for library facilities should be established.

Services Provided by the Library

A review of all services currently provided in the light of changing needs and expectations shall be undertaken. This goals are explained Table IV.34.

Table IV.34 Services

Services	➤ Realign the suite of services provided to accommodate new demands (e.g. changed opening hours, web based enquiry services etc)
	➤ Build a flexible infrastructure capable of responding nimbly to changing needs
	➤ Establish strong channels of communication with all types of users i.e. robust communications with faculties
	➤ Implement robust performance monitoring procedures and modify service provision as appropriate

Information Resources:

The Library should create a long-term plan for management and development of the University's information resources in all formats. This should include information resource policies for acquisition, access, development, storage etc. for each discipline.

A collaborative approach to site licensing of digital material and electronic journals should be established among National academic institutions (Monaghan, 2003). Scope of the Studies on Developing Library Services is summarized in Table IV.35.

Table IV.35 Comparison of Literature on Developing Library Services

Applied Studies	Document Type	Application Year	Scope of the Study
Charles Sturt University Library	Survey Results	2008	Answers following topics: "What is important for the library?" "The evaluation of performance of the library", "Where clients believe the library can potentially improve?"
The University of Illinois Library	Strategic Plan	2003	Plans strategically; Expanding The Service Orientation, Providing the Users with World-Class Collections and Resources, Building an Infrastructure for the 21st Century, Developing Resources and Partnerships for the 21st Century
Terrell	Academic Paper	2002	Defines processes for Continuous Improvement: Trend Analysis, Technology Development, Collaboration, Staff Support, Use of Space, Marketing, Assessment, and Funding
Schulz	Strategic Plan	2005	Provides initiatives identified for continuous improvement in terms of "Library as Place", "Teaching", "Information and Access", "Technology", "Marketing", "Fund Raising".
The Library of University College Dublin	Review Report	2003	Gives recommendations in terms of; organization & structure, infrastructure and technology support, space and facilities, services provided by the library and information resources.

In Improve phase, KPIs were defined after completing literature on developing library services.

IV.2.4.2 KPIs (Key Performance Indicators)

Key Performance Indicators are measurements and metrics that support and facilitate achieving critical goals of the organization. KPIs are very important for understanding and improving performance.

Based on the literature on developing services, important education KPIs in literature were shown in Table IV.36. A critical examination of the MUFE's education process during the interviews helped to identify the important KPIs in Table IV.37. These became the basis of the improved processes of education system.

Table IV.36 Important Education KPIs in Literature

KPIs	➤ Space and Facilities
	➤ Technology Development
	➤ Service Skills
	➤ New and Innovative Services
	➤ Encouraging Staff
	➤ Information Technology
	➤ Reputation

Table IV.37 Important Education KPIs Determined from the Interviews

KPIs	➤ Staff development
	➤ Timely and quality service
	➤ Accessibility
	➤ Image and reputation
	➤ Positive customer
	➤ Experience

This applied study in MUFE is a suggested model. Improve phases shall be conducted in the based upon the suggested solutions.

IV.2.4.3 Developed Model for Solution

A complete analysis of the Education process provided answers on how the above shortcomings could be eliminated. The solutions suggested to overcome the deficiencies were:

Improving the Quality of the Educational Programs

MUFE will try to increase all the education and training programs operating in academics and the quality of educational services. For this purpose, MUFE should put into progress the needed improvement and incentive effort and improvements should be set out as a general goal. In this context, one of the key strategic objectives has been identified as improvement the quality of the Education and Training under the Bologna process. In MUFE, integrity of the courses in doctoral programs, graduate and undergraduate programs should be provided and the courses should be in compliance with program objectives. Programs and Work to be done within the framework of Bologna process should be institutionalize. Also, programs began in the Departments must be consistently controlled every year.

In addition, multi-disciplinary education and training programs to ensure collaboration of close departments should be created.

Aims

- 1) To provide institutionalization in the undergraduate education
- 2) To improve the course contents and to improve quality of the programs
- 3) To develop multi-disciplinary programs
- 4) To improve knowledge and skills of faculty members, research assistants and students in the Universities Abroad.
- 5) To follow the recent scientific literature closely in the graduate programs
- 6) To work with young and successful faculty members
- 7) To improve the effectiveness of field works
- 8) To improve English education services provided to students

Improving Student Quality

Providing more rigorous and detailed training and education programs for students, and keeping the number of students per faculty member at reasonable levels, and raising high-quality graduates should be targeted. For that reason, students' exam results should be improved. The promotion activities of the University should be increased. In addition, it should be also targeted to increase employment opportunities of graduates.

Aims

- 1) To have students who get higher percentage in the university entrance exam.
- 2) To accept admission of qualified students to MUFE.
- 3) To increase number of faculty members
- 4) To increase the number of students within the capacity of departments.
- 5) To increasing the number of graduate students that complete program
- 6) To help the graduates to be employed by developing cooperation with industry
- 7) To improve scholarship opportunities to the students

Developing the Research Infrastructure

Improving laboratory facilities, equipment and infrastructure in MUFE should be the objectives of the university's top priority.

Additionally, MUFE should apply more number of domestic and foreign projects in order to find financial support for scientific researches. Improving the quality of scientific research activities in MUFE should be aimed.

Aims:

- 1) To improve project activities in MUFE.
- 2) To improve the quality of the graduate thesis advisor support which provided by the faculty members.
- 3) To make more effective of the thesis evaluation process.
- 4) To identify of the research areas.

Increasing the Number and the Quality of the Scientific Publications

Doing advanced level research and having publications in the science and technology should be embraced by all the faculty members. MUFE should be one of Turkey's best Faculties for the number of publications per faculty member. In this context, high quality and large number of the publication is important for the presentation of the MUFE.

Aims:

- 1) To consider the numbers and quality of faculty members' publication, while selecting the faculty members for MUFE.
- 2) To encourage faculty member and research assistants to make the scientific publications.

Increasing the Public and Private Sector Activities of Faculty Members

MUFE should make collaborative research and developments by working with industry about new projects.

Aims:

- 1) To get new projects
- 2) To develop services of departments

Reputation of MUFE

MUFE should be introduced to academic environment and to students with various public relation activities and through audio-visual media. Development of the contents of the MUFE's internet website, translation into foreign languages and constantly keeping up to date is an important activity in terms of the advertisement.

MUFE should be in communication with the graduates and support graduates after graduation in order to place MU in one of the best universities.

Status, achievements and contributions to society of the graduates after graduation are an important indicator. When the recognition of MUFE gets higher, more successful students are considered to apply for the graduate programs.

Aims

- 1) Developing the web pages of institute
- 2) Preparing posters and brochures for the university's recognition
- 3) Advertising MUFE through the press and publication organs
- 4) Improving effectiveness of the alumni association and continue to communicate with graduates after graduation.

Making More Effective and Efficient Business Processes Related to Administrative and Academic Activities

A good system needs to be created for successfully conducting academic and administrative activities. In addition, training on the job and satisfaction of the staff also should be targeted to increase.

Aims:

- 1) To create an effective management and information systems
- 2) To establish an effective internal control system
- 3) To hire administrative staff in enough numbers
- 4) To do internal training seminars in regular basis in order to educate administrative staff.
- 5) To Improve the employee satisfaction

Improving the Services Provided to Students and Employee

Dormitories provided to students at the university are an important factor. Thus, the quality of admitted students in the MUFE will be increased. In order to build new and modern student dormitories, the required initiatives should be planned to apply to relevant government institutions and organizations.

Cafeteria and canteen facilities need to be reformed. Additionally, it is aimed to increase the quality of services provided by student affairs to students and employees.

Aims:

- 1) To improve the service of student affairs
- 2) To develop the information and technology services
- 3) To improve the health, culture and sport services
- 4) To provide accommodation for students inside the campus

Developing of the Library Services

One of the most primary objectives of the university library is that all students should be active participants in the learning process. Students should develop self-direction and independence in learning how to search and acquire information by using the materials and technological informational resources provided in the university library. General quality management process in library is represented in Figure IV.13.

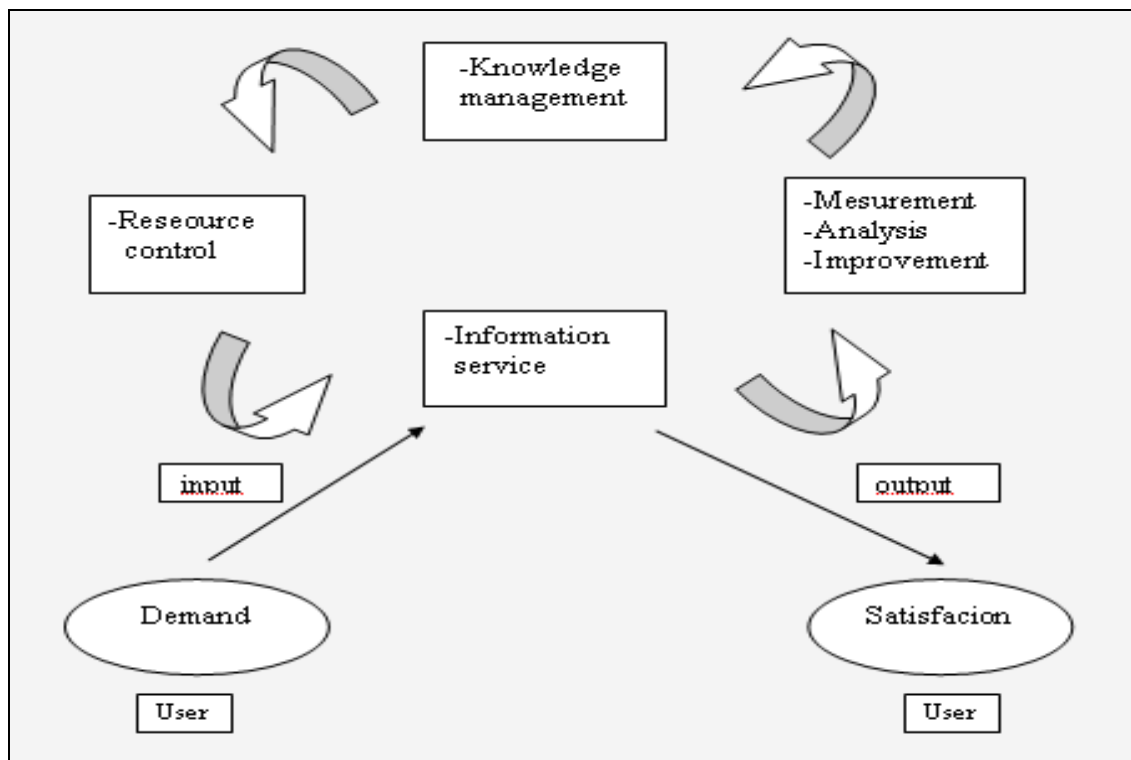


Figure IV.13 Quality Management Process in Library (Amheiter, 2005)

To meet the informational needs of all students, university library should function effectively by supporting and extending the instructional curriculum program of each grade level of the university. By allowing every student time to pursue an interest in the university library, skills in reading, observing, listening, and communicating will be strengthened.

The objective here is to improve services offered by the library in order to make services more efficient. Service improvement can be provided in terms of technical service process, and library automation. To become familiar with different processes of the library, interviews have been carried out with some of the library staff and employees.

Aims:

- 1) To decrease the required time to process user's requests through telephone, e- mail or in person, and time spent on checking, updating and shelving the library resource such as books, journals, microfilms, etc.
- 2) To keep the number of staff involved in the technical services, loans, and user services, and library automation and digital services.
- 3) To lessen the cost involved in technical services, loans, and user services, and library automation and digital services.
- 4) To provide the self-service machines for counter transactions.
- 5) To develop the skills of the staff through education and training.
- 6) To provide timely and quality service.
- 7) To make the books and digital library services available as quickly and as efficiently as possible.
- 8) To have better image and reputation of the library as seen from a customer's point to view.
- 9) To improve the physical ambience of the library premises and to add features such as laptop charging areas etc., to make the library users feel comfortable.

When above mentioned aims of this study were compared to the Literature on Developing Library Services, the following statements were observed:

- 1) The survey, which was applied to Charles Sturt University Library, can be applied to Library of Marmara University to answer following topics: “What is important for the library?” “The evaluation of performance of the library”, “Where clients believe the library can potentially improve?”

- 2) The University of Illinois Library Strategic Plan included Building an Infrastructure, Developing Resources and Partnerships, which were parallel goals with this study's aims.
- 3) Technology Development, Staff Support and Use of Space were aims of Terrell (2003), which were similar to the results of this study.
- 4) Schulz defined "Information and Access", "Technology" for continuous improvement of the library. It was observed that these two items were comparable to the aims of this study.
- 5) All recommendations (organization & structure, infrastructure and technology support, space and facilities, services provided by the library and information resources) of Review Report related to The Library of University College Dublin, were in parallel with the results of this study.

As it's mentioned above, university libraries are so important for acquiring of the information. For that reason, a special importance shall be given to library services by Marmara University. In order to improve the library services, the study area of the building should be increased and information resources of the library of Marmara University should be developed.

IV.2.5. Control

The purpose of this stage is to hold on to the improvement achieved from the last stage. The change made in the improvement stage shall be documented. If the improvement is made by process management methods, such as process simplification, a new process standard shall be established. If the improvement is made by eliminating the root causes of low performance, process performance shall be kept track of after improvement. Critical variables relating to performance shall be controlled by using control charts. The last phase of Six Sigma methodology focuses on the development of procedures to maintain the gains realized in the Improve phase (Amheiter, 2005).

Six areas of Control are critical in service environments:

- 1) Making sure the improved process is documented,
- 2) Turning results into funds,
- 3) Maintenance of gains is verified to the lowest level,
- 4) Checking the performance variations,

- 5) Guiding the implementation,
- 6) Developing a control plan

As stated previous sections, in Define and Measure Phases processes have been evaluated by using Qualitative Analysis Methodology, in Analysis Phase collected data have been analyzed by using Kano Model and in Improve Phase solutions have been generated for each process.

Similar to Improve Phase, Control Phase shall be done according to Stage 6 of Process Flow Chart, which includes adjusting the process performance due to student/faculty member requirements and controlling the process.

During 2009-2010 academic years, Prof. Dr. Ercan ÖZTEMEL's chairmanship established a strategic planning process in MUFE. The purpose of this planning process was to identify the problem and to provide improvement for subsequent periods. As a result, the similar processes were obtained in the Strategic Planning Process. In the scope of Strategic Planning Process, a survey was conducted for students by Asst. Prof. Dr. S.Serdar YÖRÜK. The results were shown in Table IV.38. In addition to the findings of Qualitative Research Methodology, the findings of defined survey were included in this study. (Öztemel and Yörük, 2009)

Table IV.38 SWOT

STRENGTHS
➤ Having education in English language ➤ Having less quota and having close relationship between students ➤ Finding easier job comparing to other faculties and other departments in our Engineering Faculty. ➤ Having educators with strong career ➤ Having more long established engineering experience comparing many universities in our country. ➤ Completing final projects in more active and dynamic way by doing application.

Table IV.38 SWOT (Continued)

WEAKNESSES
➤ Operating decision mechanisms without student focus. ➤ Not providing online information nor class note sharing ➤ Not including enough information the web pages of university ➤ Deficiency of conference room ➤ Not giving importance to Student Clubs and not providing enough funds. ➤ Having insufficient laboratories, not having some of the required laboratories (for example, Manufacturing Laboratory integrated with computer laboratory ➤ Deficiencies of Laboratories in technological base (turning off wireless internet access) ➤ Not having flexible structure for selecting course within the department, selecting course from subsequent years, quota limitation, having double main branch, having additional branch, not being able to select course from other departments ➤ Having many bureaucratic steps in university's internal processes ➤ Necessity of having a course from a single determined faculty member ➤ Not having selective courses in order to improve social sides of Industrial Engineering Students (Philosophy, Sociology, Society History)
OPPORTUNITIES
➤ Increasing the requirement of engineering knowledge in national and international field. ➤ Becoming easier to follow closely developments in engineering education by improvement of technology and increasing accessibility to information ➤ Having variety of work field. ➤ Increasing opportunity of graduate education by teaching second foreign language ➤ Increasing relationship with the other departments in MUFE ➤ Having close relationship with the graduates and by sustained relationship completing lifelong learning in theoretical field and completing institutional identity.

Table IV.38 SWOT (Continued)

THREATS
➤ Having the first Industrial Engineering distant learning program application in Sakarya University, ➤ Giving education without process of engineering ethics and process of scientific information in engineering education ➤ Not being educator face to face with student and not having mutual interaction ➤ Not having question-answer mechanism in education and expectancy of increase in number of distant learning programs. ➤ Having new universities by Turkish Council of Higher Education and having Industrial Engineering Departments in new universities. ➤ Replacement of diplomas with certificate programs provided by institutions with suspicious content and competence due to transformation in education. ➤ Erosion in vocational personal rights and in salaries and increasing fear of unemployment due to 2009 economical crisis.

The application of survey and evaluation of results in Faculty SWOT Analysis For Strategic Planning Committee was put into progress after developed Taxonomy of this applied study. It shall be noted that the survey was applied to students of MUFE, but on the other hand this study was applied to staff, research assistants and faculty members including Dean of MUFE. These two studies applied independently and it was observed that there were similar and different results in terms of education process in MUFE.

This study and Faculty SWOT Analysis For Strategic Planning Committee provided similar results because Strengths and Weaknesses of SWOT Analysis were composed of “Internal Environmental Factors”. These similarities were; Improvement of relations with national and international business environment and civilian public associations, Increasing number of social service projects, Providing the cooperation of the institute and industry, improving application and service processes in the MUFE, Advertising to MUFE by media, Increasing effectiveness of community of graduates and keeping in touch with the graduates, Composing, enhancing and updating of education and training programs, Supporting of students’ academical education, Having programs in the IED of MUFE prepared for

accreditation, Improvement of living and working conditions of students and faculty members, Improvement of Educational Infrastructure, Improvements to the Physical Infrastructure of Institute and Increasing Quality and Quantity of Science and Technology.

However, Threats and Opportunities of Faculty SWOT Analysis For Strategic Planning Committee were fundamentally composed of “External Environmental Factors”. These Threats and Opportunities were detailed by Faculty SWOT Analysis For Strategic Planning Committee.

As a result of measuring and evaluation of processes in this applied study, the suggestions are listed in Table IV.39 according to the generated solutions in Improve Phase;

Table IV.39 Collective Data for Control Phase

PROCESSES	COLLECTIVE DATA
Developing of the library services	Number of visits to the online database.
	Number of downloaded papers which are in citation index
	The proportion of the number of the books, journals and documents to number of students
	Ratio of books procurement per faculty member
	Period of books procurement for faculty members
MUFE’s collaboration with industry	The number of products and services of the industrial institutions in collaboration with MUFE.
Improvement of academic staff	Ratio of faculty member and research assistant per student
Improvement of physical infrastructure	Classroom area per student
	Number of student per computer
	Number of personnel per computer
	Number of education appliances per classroom

Table IV.39 Collective Data for Control Phase (Continued)

Improving student quality	University entrance scores of students for undergraduate programs
	Percentage of students who graduate in 4 years for undergraduate programs
	The cumulative GPA (Grade Point Average) of undergraduate students for each year
	The number of applicants for graduate programs
	The GPA of graduate students
	Rank of MUFE in University Entrance Exam
	Number of transfer applications.
Development of financial resources	The amount of Revolving Fund revenue
	The amount of Non-thesis master of business administration program income
	The amount of R&D (Research and Development) and technological development activities income
Improving the quality of the educational programs	Number of courses in each curriculum
	Number of courses in graduate programs
	Number of engineering programs
	Number of degrees awarded for undergraduate and graduate programs
Increasing the number and the quality of the scientific publications	Ratio of A class publications per faculty members (Science Citation Index, social citation index, engineering index)
	Ratio of B class publications per faculty members.
Reputation of MUFE	Number of conference scheduled and organized by MUFE
	Number of fairs / expositions that MUFE participated and opened a stand
	Number of visits to high schools

This applied study in MUFE is a suggested model. Control phases shall be conducted in the based upon the defined collective data.

PART V

RESULTS & DISCUSSION

Six Sigma as a powerful business strategy has been around for almost twenty years and has grown exponentially in service sector. As a process performance improvement methodology, Six Sigma is viewed today as a disciplined, systematic, measurement-based and data-driven approach to reduce process variation. This powerful management strategy combines improved metrics and applicable methodology to reduce defects or mistakes or errors in processes and thereby strengthening a company's market position and enhancing the financial impact to the bottom-line. In manufacturing, it is quite possible to reduce or even eliminate (in some cases) most of human variability through automation. In service sector, the delivery of person is largely a human process, and hence the causes of variability are often difficult to identify and quantify.

The fact that quality concept has gained importance in many areas and education has existed in human's life from past to present required that these two concepts have been considered together. Even though, there are a lot of studies related to quality of education, but there are small number of researches related Six Sigma in the education sector. However, to be competitive in universities, largely depends on technological innovation in the move, academic activities, education quality and improving infrastructure and social amenities that improve the satisfaction of student and employee. Six Sigma Method, which allows to shorten effective communications, team works and decision-making process, is one of the most important components for our University's long term success to be able to cope with the other competitors in the world.

Process of a quality education, student and employee satisfaction to have adopted the Six Sigma Method is known to be a necessity according to the terms of the competitive era. However, very few universities have comprehended the importance of understandings of Six Sigma Methods. In the global competitive

environment, to get the advantage of "speed-quality-cost" triple, the Universities are required to adapt the Six Sigma Approach to their own structures. Universities, which can achieve to maximize their productivity with Six Sigma, will be able to be leaders in international competition between universities.

The first part of this study, the goals were explained and introduction was made. In the second part, general information has been given about the Marmara University. In the third part, the information has been given about the Qualitative Research. In the fourth part, the improving of the educational process in Marmara University has been studied with the Six Sigma approach. This study been strengthened by using Qualitative Analysis Methodology interviews with faculty members and research assistants. According to the results of the interviews, the issues considered improvable have been emphasized primarily. Process improvement efforts in this regard were described in detail.

During the literature review, it was seen that there were small number of publications Six Sigma applications in service sector. But on the other hand, it was shown that the applications in finance sector and healthcare sector etc. provided improvements and developments (Antony et al., 2007). With this applied study, an application in education field used Six Sigma Method.

As a result of research, it was shown that the philosophy of Six Sigma has not been settled at the Marmara University yet. First of all, Six Sigma method shall include continuous improvement. In this context, MUFE is required to improve the quality of the education for academic and administrative staff. MUFE should often organize panels; in-service education programs etc. about the Six Sigma.

This study can contribute that faculty members' and research assistants' views can be taken place and more effective strategies can be found in the process of providing more qualified education in Marmara University.

Qualitative Research Methodology was used in Six Sigma Method. Due to the uneasiness of data collection and limitations, Qualitative Research was chosen for Six Sigma application. Qualitative results were obtained by using Qualitative Research Methodology. The interviews enabled the research to obtain detailed results to the root causes of the problems. Based on the "Control Data After Improvement" which constituted Control Phase of this applied study, Quantitative Analysis can be put into progress by collecting control data. The application of control phase which requires Quantitative Analysis is left to the following researches in the field.

In the literature, there is still small number of studies application of Kano Model in parallel with Six Sigma Method. Kano Model aims customer satisfaction and targets to meet the level of customer expectation. In this study, Kano Model classified the processes which were evaluated by applying Qualitative Research Methodology. This classification was made based on the interviews, for that reason it would be suggested to verify and to re-evaluate Kano Model classification based on the results of Quantitative Analysis which would be done in following researches. Kano Model application in Analysis Phase of Six Sigma Method has been one of first studies in the literature.

Improvement of library was considered initially applicable process based on the Kano Model. As a result of interviews, it was evaluated that a special importance and priority should be given to library services development by Marmara University, MUFE and Industrial Engineering Department.

There are several barriers and challenges hidden below the surface for service sector for consideration before the implementation and deployment of Six Sigma business strategy. The first and foremost challenge is the application of DMAIC Methodology in service sector. The absence or difficulty to obtain the baseline data on process performance is another major challenge while applying Six Sigma in service sector. There will be lots of data available in service sector, however, most of the time these data are not readily available for its analysis. For service sector, it is often a struggle to identify processes which can be measured in terms of defects or errors per million opportunities. Another barrier to Six Sigma deployment in service sector is the psychology of the workforce (Taner, 2008).

In order to overcome the barriers in implementation of Continuous Improvement, barrier removal strategies were addressed. These strategies were; demonstration of success, CEO sponsorship of a cohesive business strategy, good selection criteria, continuing education and coaching and workshops for management. To overcome the challenges of Continuous Improvement Implementation, following challenge removal strategies could be implemented: Leadership visibility and involvement, a well defined deployment strategy, top-down approach for initially driving support, financial enticement (O'Rourke, 2005). In following researches in the field, these suggested barrier and challenge removal strategies can be applied.

The developed Taxonomy and results of Faculty SWOT Analysis For Strategic Planning Committee were compared to each other in the scope of education processes in MUFE. It was observed that there were some similar and different results. This study and Faculty SWOT Analysis For Strategic Planning Committee provided similar results because Strengths and Weaknesses of SWOT Analysis were composed of “Internal Environmental Factors”. These similarities were defined in Control Phase of this applied study item by item. However, Threats and Opportunities of Faculty SWOT Analysis For Strategic Planning Committee were fundamentally composed of “External Environmental Factors”. These Threats and Opportunities were detailed by Faculty SWOT Analysis For Strategic Planning Committee.

One of the major comparisons was made for important education Key Performance Indicators of Library Services between KPIs in literature and KPIs determined from the interviews. KPIs in literature were; space and facility, technology development, service skills, new and innovative services, encouraging staff, information technology and reputation. KPIs determined from the interviews were: staff development, timely and quality service, accessibility, image and reputation, positive customer and experience. In literature, technology development, new and innovative services were more emphasized. On the other hand, in the interviews accessibility to the library, positive customer experience and timely and quality service were more stressed.

The other major comparison was made for “Developing Library Services” between literature and this applied study. It was seen that some of the processes were in parallel with the literature and they were summarized in following items;

- 1) The University of Illinois Library Strategic Plan included Building an Infrastructure, Developing Resources and Partnerships, which were parallel goals with this study’s aims.
- 2) Technology Development, Staff Support and Use of Space were aims of Terrell (2003), which were similar to the results of this study.
- 3) Schulz defined “Information and Access”, “Technology” for continuous improvement of the library. It was observed that these two items were comparable to the aims of this study.
- 4) All recommendations (organization & structure, infrastructure and technology support, space and facilities, services provided by the library and

information resources) of Review Report related to The Library of University College Dublin, were in parallel with the results of this study.

Additionally, if not known to taken into consideration DMAIC techniques in MUFE, vulnerabilities of MUFE are required to resolve promptly. MUFE should increase participation of the employees in quality activities. The last but not the least, the quality of education can only be increased with continuous improvement and it is important to present recommendations using the business language rather than the statistical language.

PART VI

CONCLUSION

Six sigma methods have been examined in the created model. In this examination, Six Sigma Method and Qualitative Analysis Methodology were used during the process development phase of the MUFE. As the results of the interviews, which are evaluated with the Qualitative Analysis Methodology, the most important problems have seen to be insufficient infrastructure, insufficient number of faculty members and limitations in financial resources. And these processes have established priorities and the problems that mostly repeated have been introduced.

In Industrial Engineering Department, recent academical processes are assumed to be needed development. And this requirement leads to reorganization, and/or to need for new process. After reviewing the literature, it has been observed that there are few numbers of Six Sigma study in the field of education process development.

For that reason, Quality Analysis Methodology has been put into progress by having interviews. Dean, 7 Faculty Members of MUFE, 4 Research Assistants and 3 Library Staff have been interviewed about recent academical process and its developable sections.

By using a case method, the faculty members' and research assistants' perceptions, concerns, and interpretations in the context of their interactions with the cooperating them and department chairperson have been examined. The purpose has been to evaluate totally new ideas for education process of MUFE based on their experience. Each interview has lasted between 30 minutes to 2,5 hours. Intentionally, interviews have been completed face to face and one by one to avoid any manipulation. After evaluating the shortcomings of the Education Process, aims for improvable areas have been identified based on the interviews. The second series of interviews have been done with the Faculty Members in the scope of already identified shortcomings and aims for improvement.

At the end of interviews, Interview Framework has been evaluated. As Interview Framework has been outlined in the Define Phase, there were major headlines that need to be improved or increased: quality in education and training, education infrastructure, human resources and satisfaction, quality and quantity of science and art, physical infrastructure of institute, environmental cooperations and social service projects, financial resources, reputation of the institute, quality and quantity of academical papers and finally, institutionalizing strategic plan process.

In Measure phase, Education system has been determined with all the variables that impact the process inputs as well as the process outputs. Outputs of the process were used to determine such characteristics as process capability, stability, reproducibility, and repeatability. Data Collection has been performed by using Qualitative Research case method. The major repeated findings have been related to background of faculty members, student selection criteria, and buildings, classrooms and laboratories.

In Analysis Phase, ‘Must-Be’ requirements, One-Dimensional requirements and Attractive requirements have been evaluated by using Kano Model based on the results of the interviews in Define and Measure Phases.

A Taxonomy, which was including CTQ and Education Theoretical Model, has been developed. The Taxonomy has enabled us to evaluate the Process and the purpose of this Process. However, the real purpose of developing the Taxonomy was to define the processes which were required to be improved correspond to the results of the interviews.

Additionally, the aims have been given in detail according to the defined process in the developed Taxonomy. For example, in order to improve the quality in education and training; education and training programs shall be composed, enhanced and updated, students’ academical education shall be supported, IED of MUFE shall have programs prepared for accreditation, living and working conditions of students and faculty members shall be improved.

Another example may be the Increasing Quality and Quantity of Science and Art. In the Taxonomy, some goals have been defined for this improvement: Effectiveness of Research and Application Centers shall be improved, number of research projects shall be increased, quality of international workshops managing by IED of MUFE shall be increased, and organizations like seminar, symposium and workshop at national and international level shall be performed.

After Taxonomy Development, the processes were classified in Kano Model as 'Must-Be', One-Dimensional, and Attractive requirements.

In Improve Phase, creative solutions needed to be found. The goal of this step was to determine the appropriate solutions to implement using objective means, rather than making a decision based on assumptions or preferences.

At the end of second meetings with faculty members, the following results were obtained for the development and improvement of education processes in MUFE. The results enabled the study to propose solutions for complete education process.

For improving the quality of education's programs; institutionalization in the undergraduate education shall be provided. The course contents and quality of the programs, knowledge and skills of faculty members, research assistants and students, the effectiveness of field works, English education services provided to students shall be improved. Multi-Disciplinary Programs shall be developed. In the Graduate Programs, the Recent Scientific Literature shall be followed closely. MUFE shall work with Young and Successful Faculty Members.

For Improving Student Quality; The MUFE shall accept the students who get higher percentage in the university entrance exam and accept the admission of qualified students. Number of Faculty Members, the Number of Students within the capacity of departments, the number of Graduate Students that complete program shall be increased. MUFE shall help the graduates to be employed by developing cooperation with industry. Scholarship Opportunities to the students shall be improved.

For developing the research infrastructure; MUFE shall improve the project activities. The quality of the graduate thesis advisor supports, which provided by the faculty members, shall be improved. This study evaluation process shall be more effective. More research areas shall be identified.

For increasing the number and the quality of the scientific publications; MUFE shall be one of Turkey's best universities for the number of publications per faculty member. The amount and quality of faculty members' publication shall be increased. Faculty members and research assistants shall be motivated to make scientific publications.

For reputation of MUFE; the web pages of MUFE shall be developed. Posters and brochures for the university's recognition shall be prepared. MUFE shall be

advertised through the press and publication organs. Effectiveness of the alumni association shall be improved and communication with graduates after graduation shall be kept on.

For making more effective and efficient the business processes related to administrative and academic activities; an effective management and information systems shall be created. An effective internal control system shall be established. Administrative staff shall be employed in enough numbers to perform internal training seminars in regular basis. Employee satisfaction shall be improved.

For improving the supportive services provided to students and employee; the supportive service of student affairs and the health, culture and sport services shall be improved. The information and technology services shall be developed. Accommodation for students inside the campus shall be provided.

For developing of the library services; the required time to process user's requests through telephone, e-mail or in person, and time spent on checking, updating and shelving the library resource such as books, journals, microfilms, etc. shall be decreased. The number of staff involved in the technical services, loans, and user services, and library automation and digital services shall be kept. The cost involved in technical services, loans, and user services, and library automation and digital services shall be lessened. The self-service machines for counter transactions shall be provided. The skills of the staff through education and training shall be developed. Timely and quality service shall be provided. The books and digital library services shall be made available as quickly and as efficiently as possible the library shall have better image and reputation as seen from a customer's point to view. The physical ambience of the library premises shall be improved and features such as laptop charging areas etc. shall be added to make the library users feel comfortable.

In Control Phase, the necessary data collection has been outlined in accordance with the generated solutions in Improve Phase.

For developing the library services; number of visits to the online database, number of downloaded papers which are in citation index, the proportion of the number of the books, journals and documents to number of students, ratio of books procurement per faculty member and period of books procurement for faculty members shall be recorded and measured. For MUFE's collaboration with industry; the number of products and services of the industrial institutions in collaboration with MUFE shall be collected and evaluated.

Improving student quality; university entrance scores of students for undergraduate programs, Percentage of students who graduate in 4 years for undergraduate programs, the cumulative GPA of undergraduate students for each year, the GPA of graduate students, rank of MUFE in university entrance exam, number of transfer applications and the number of applicants for graduate programs shall be recorded.

Development of financial resources; the amount of revolving fund revenue, the amount of non-thesis master of business administration program income and the amount of R&D and technological development activities income shall be collected and measured.

Improving the quality of the educational programs; number of courses in each curriculum, number of courses in graduate programs, number of engineering programs and number of degrees awarded for undergraduate and graduate programs shall be obtained.

Increasing the number and the quality of the scientific publications; ratio of class publications per faculty members (science citation index, social citation index, and engineering index) and ratio of b class publications per faculty members shall be acquired.

Reputation of MUFE; number of conference scheduled and organized by MUFE, number of fairs / expositions that MUFE participated and opened a stand and number of visits to high schools shall be got.

Improvement of academic staff; ratio of faculty member and research assistant per student shall be recorded and measured.

Improvement of Physical Infrastructure; classroom area per student, number of student per computer, number of personnel per computer and number of education appliances per classroom shall be collected.

This applied study in MUFE is a suggested model. Improve and Control phases shall be performed based upon the suggested solutions and defined collective data.

REFERENCES

- Amheiter, E.D.: “The integration of Lean Management and Six Sigma”, *TQM Magazine*, **(2005)** 5–18.
- Andersson, R., Eriksson, H.; Torstensson, H.: “Similarities and Differences between TQM, Six Sigma, and Lean, *The TQM magazine*, **(2006)**. 282-296.
- Antony, J.; Banuelas, R.: “Key Ingredients for the Effective Implementation of a Six Sigma Program”, *Measuring Business Excellence*, **(2005)** 10-17.
- Antony, J., Downey-Ennis, K., Antony, F.; Seow, C.: “Can Six Sigma be the cure four our ailing NHS?”, *Leadership in Health Services*, **(2007)** 242- 253.
- Antony, J.: "Six Sigma for Servic Processes", *Business Process Management Journal*, **(2006)** 234-248.
- Arnheiter, E.D.; Maleyeff, J.: “Research and Concepts: the Integration of Lean Management and Six Sigma”, *The TQM Magazine*, **(2005)** 5-18.
- Bank, J.: “The Essence of Total Quality Management”, *Prentice-Hall Europe*, **(2000)** 16-19.
- Banuelas, R.; Antony, J.: “Critical Success Factors for the Successful Implementation of Six Sigma Projects in Organizations”, *The TQM Magazine*, **(2002)** 92-99.
- Basu, R.: “Six-Sigma to Operational Excellence: Role of Tools and Techniques”, *International J. of Six Sigma and Competitive Advantage*, **(2004)** 44-64.
- Bin-feng, L.; Zhi-xin, L.: “Six Sigma Management Method: A Scientific and Effective Management Model”, *J. Science-technology and Management*, **(2003)** 33-36.
- Bo, X.: “ Elements of Driving the Success of the Six Sigma Management,” *Market Weekly Disquisition Edition*, **(2005)** 17-18.
- Bodie, C. A.: “Railroad History in the Shenandoah Valley: A Review of Sources”, *James Madison University Library*, **(2001)**.
- Breyfogle. F.W.; Cupello, J.M, and Meadows, B.: “Managing Six Sigma: A Practical Guide to Understanding, Assessing and Implementing The Strategy that Yields Bottom-line success”, 1 st Edition.; Danvers, M.A., Editors.; Wiley, J. Inc., New York, USA, **(2005)** 19-24.

- Chakrabarty, A.; Tan, K.C.: "The Current State of Six Sigma Application in Services, Managing Service Quality", **(2007)** 194-208.
- Daft, R.L.: "Organization Theory and Design", 7th ed. South- Western, Mason, OH, **(2001)** 18-24.
- Dean H.W.; Bowen, D.E.: "Management Theory and Total Quality", *Improving Research and Practice Through Theory Development Academy of Management Review*, **(2003)** 392-418.
- Devane, R.: "Integrating Lean Six Sigma and High-Performance organizations", *Leading the charge toward dramatic, rapid and sustainable improvement*, San Francisco, **(2006)** 91-100.
- Dittrich, P.S. and Manz, A.: "Lab-on-a-chip: microfluidics in drug discovery", *Nat. Rev. Drug Discovery*, **(2006)** 210–218.
- Dunaway, W.: "History of the James River and Kanawha Company", *Columbia University*, New York, **(2003)**.
- Eckes, G.: "The Six Sigma Revolution: How General Electric and Others Turned Process into Profits", John Wiley & Sons, New York, **(2001)**.
- Feng-zhang, Z.; Ming-peng, J.: "The Human Resource Management of Six Sigma Management System," *J. Si Chuan Arm-Transaction*, **(2004)** 8-11.
- Glanz, J.: "Fundamentals of Educational Research: A guide to Completing a Master's Thesis", *Christopher Gordon Publishers*, **(2006)** 221-231.
- Guang-ling, W.; Chun-hua, Z.: "Analysis on Six Sigma Management and Enterprise Competitive Advantage," *Shan Dong Social Science*, **(2006)** 125-127.
- Gupta, P.: "A Statistical Guide to Optimizing Results", *Six Sigma Performance Handbook*, New York, **(2004)** 129-138.
- Hahn, G.J.; Hill, R.W.: "The Impact of Six Sigma Improvement-A Glimpse into the Future of Statistics", *The American Statistician*, 532, **(2007)** 208–215.
- Harry, M.; Schroeder R.: "Six Sigma: The Breakthrough Strategy Revolutionizing the World's Top Corporations", New York, NY, Currency Doubleday, **(2000)**.
- Hensley, L.; Dobie, K.: "Assessing Readiness for Six Sigma in Service Setting", *Journal of Managing Service Quality*, **(2005)** 82-101.
- Hiller, S.: "Charles Sturt University Library Client Survey Results", *Library Client Survey Report*, USA, **(2008)** 107-134.

- Hwang, Y. D.: "The practices of Integrating Manufacturing Execution Systems and Six Sigma methodology", *International J. of Advanced Manufacturing Technology*, **(2006)** 145–154.
- Jorgenson, D.L.: "Participant Observation", *Newbury Park*, **(2008)** 14-19.
- Kanji, G.K.: "Measurement of business excellence. Total Quality Management", **(2003)**663–43.
- Klefsjo, B.; Wiklund, H.; Edgeman, R. L.: "Six-Sigma Seen as a Methodology for Total Quality Management", *Measuring Business Excellence*, **(2001)** 31-35.
- Kline, R.: "Principles and Practice of Structural Equation Modeling", *Guilford Press*, New York, USA, **(1998)** 189-209.
- Kwak, Y. H.; Anbari, F. T.: 'Benefits, Obstacles and Future of Six Sigma Approach', *Technovation*, **(2004)** 708-715.
- Lamnek, S.: "Qualitative Sozialforschung", *Lehrbuch Auflage Beltz Verlag Weihnhein*, 4st Edition, Basel **(2005)** 23-34.
- Leedy, P.D.; Ormrod, J.E.: "Practical Research Planing and Design", *Pearson Education International*, 8th Edition, **(2005)** 18-27.
- Liker, J.K. and Thomas Y.C.: "Becoming Lean: Inside Stories of U.S. Manufacturers: The Successes and Failures of Implementing Continuous Improvement Programs: Cases of Seven Automotive Parts Suppliers", *Productivity Press*, Portland, OR , **(1998)** 36-40.
- Loseke, R.; Cahil, S. E.: "Publishing Qualitative Manuscripts: Lessons Learned", *Qualitative Research Practice: Concise Paperback Edition*, **(2007)** 491-506.
- Miles, M.B.; Huberman, A.M.: "Qualitative Data Analysis: A Sourcebook of New Methods", Beverly Hills, CA, **(2003)**.
- Min, W.: "Challenge of Six Sigma Management to the Theory of Conventional Quality Cost", *J. Semiconductor Technology*, **(2006)** 17-29.
- Mohr, I.; Jackson, J.: "Conceptualising total quality orientation", *European Journal of Marketing*, **(2005)**13–22.
- Monaghan, M.: "Quality Assurance/ Quality Improvement Review Group ". *University College Dublin*, **(2003)** 22-56.
- Motwani, J.; Kumar, A.; Antony, J.: "A business Process Change Framework for Examining the Implementation of Six Sigma: Case Study", *The TQM Magazine*, **(2004)** 273-283.
- Nimsomboon, N.: "Assessment of Library Service Quality at Thammasat University

- Library System”, *Department of Library Science Faculty of Liberal Arts Thammasat University, Thailand*, **(2003)** 23-27.
- Nitecki, D. A.; Hernon, P.: “Measuring Service Quality at Yale University's Libraries”, *Journal of Academic Librarianship*, **(2003)** 259-273.
- Nitecki, D.A.: “Changing the Concept and Measure of Service Quality in Academic Libraries”, *Journal of Academic Librarianship*, **(2005)** 181-191.
- O’Rourke, P.: “A Multiple-Case Analysis of Lean Six Sigma Deployment and Implementation Strategies”, *Department of the Air Force Air University*, **(2005)** 12-23.
- Öztemel, E.; Yörük, S.S.: “Faculty SWOT Analysis For Strategic Planning Committee”, *Internal Report in Marmara University Engineering Faculty*, **(2009)**
- Pande, P.S.; Neuman, R.P.; Cavanagh, R.R.: “The Six Sigma Way, How GE, Motorola, and Other Top Companies are Honing Their Performance”, New York, McGraw Hill, **(2007)** 23-27.
- Pande, P.S., Neuman, R. P. and Cavanagh, R.R.: “The six sigma way: how GE, Motorola, and other top companies are honing their performance”, McGraw-Hill, New York, **(2000)**.
- Patton, M. Q.: “Qualitative Research and Evaluation Methods”, *Sage Publications*, 3rd Edition.; Thousand Oaks, CA, USA, **(2002)** 110-123.
- Proudlove, N.: “Lessons for Lean in Healthcare from Using Six Sigma in the NHS”, *Public Money and Management*, **(2002)** 21-27.
- Ricondo, I.: “Six Sigma and its Links to TQM, Lean and the Learning Organization”, *International J. of Six Sigma and Competitive Advantage*, **(2003)** 323-354.
- Ritchie, J.: “A Qualitative Study of the Role of GPs in the Award of Invalidity, Benefit”, London, the Stationery Office, **(2006)** 1-3.
- Robert P.: “Basic Content Analysis”, *Recommended Introductory Reading*, 2nd Edition; Newbury Park, CA, USA, **(2005)** 2-10.
- Scribe, A.: “APA Research Style Crib Sheet” **(2006)** 10-19.
- Schroeder, R.G.; Linderman, K.; Liedtke, C. and Choo. A.: “Six Sigma: Definition and Theory”, *J. Op. Man.*, **(2008)** 536–554.
- Schroeder, R. G.; Linderman, K.; Liedtke, C.; Choo, A. S.: “Six Sigma: Definition and underlying theory”, *J. of Operations Management*, **(2008)** 536- 554.
- Schulz, J.: “The University Library At Sonoma State University Planning Priorities,

- 2005-2008", *Sonoma State University*, **(2005)** 664-2397.
- Shah, R.: "Lean Manufacturing: Context, Practice Bundles and Performance", *Operations Management*, **(2003)** 129-149.
- Sharma U.: "Implementing Lean Principles With The Six Sigma Advantage: How a Battery Company Realized Significant Improvements" *Journal Of Organizational Excellence*, **(2003)** 43-52.
- Sheng-li, J.: "Six Sigma Management: the New Variable of Total Quality Management", *J. Forum on Jiang Su Commerce*, **(2005)** 115-117.
- Silverman, D.: "Interpreting Qualitative Data: Methods for Analysing Talk", *Text and Interaction*, 2 st Edition, London, **(2001)** 45-48.
- Sousa, R.; Voss, C. A.: "Quality Management Re-Visited: A Reflective Review and Agenda For Future Research", *Journal of Operations Management*, 20, New York, USA, **(2004)** 91-109.
- Strauss, A.: "Qualitative Analysis for Social Scientists", Cambridge University Press, Cambridge, England, **(2006)** 224-229.
- Struck, W.; White, E.B.: "The element of Style", **(2000)** 21-29.
- Taner, M.T., Sezen, B.; Antony, J.: "An Overview of Six Sigma Applications in Healthcare Industry", *International Journal of Health Care Quality Assurance*, **(2007)** 329-340.
- Taner, T.: "Six Sigma in Healthcare Industry : Some Common Barriers, Challenges and Critical Success Factors", *Institute of Biomedical Engineering, Bogazici University, Istanbul, Turkey*, **(2008)**
- Taninecz, G.: "Lean Beyond Production", *Lean Enterprise Institute*, **(2005)**.
- Tannock, J.: "A Variation Management System Supporting Six Sigma", *Manufacturing Technology Management*, **(2004)** 561-575.
- Terrell, B. G.: "The James River Bateau: Nautical Commerce in Piedmont Virginia." *Virginia Cavalcade*, **(2002)** 180-191.
- Terziovski, M.: "Quality Management Practices and Their Relationship with Customer Satisfaction and Productivity Improvement", *Management Research News*, **(2006)** 414-424.
- Tonkiss, F.: "Analysing Discourse", *Researching Society and Culture*, London, **(2000)** 78-90.
- Webb, B.: "Methods of Social Study", *Longmans*, London, **(2002)** 65-70.
- Weiss, C.H.: "Uses of Social Research in Public Policy", *Lexington*, **(2007)** 210-232.

- Weitzman, E.A.; Miles, M.B.: "Computer Programs for Qualitative Data Analysis", *A Software Sourcebook*, **(2005)** 178-190.
- Wessel, G and Burcher, P.: "Six sigma for small and medium-sized enterprises, The TQM Magazine", **(2004)** 264-272.
- White, C.; Mitchell, L.; Orford, J.: "Exploring Gambling Behaviour Indepth: A Qualitative Study", *National Centre for Social Research*, **(2001)** 100-109.
- Whittemore, R.; Langness, L.; Koegel, P.: "The Life History Approach to Mental Retardation" *Culture and Retardation*, **(2006)** 208-210.
- Whyte, W.F.: "Participatory ActionResearch", *Newbury Park, CA, Sage*, **(2001)** 43-56.
- Wiener, C.L.: "The Burden of Rheumatoid Arthritis: Tolerating the Uncertainty", *Social Science and Medicine*, **(2005)** 97-104.
- Williams, M.: "Symbolic Interactionism: Fusion of Theory and Research" *New Directions in Sociology*, London, **(2004)** 15-29.
- Williams, M.: "Science and Social Science", *An Introduction*, London, Routledge,**(2005)** 5-12.
- Wolcott, H.F.: "Writing Up Qualitative Research", *Newbury Park, CA: Sage*, **(2001)** 24-35.
- Woodfield, K.: "They All Wear White Coats Don't They? Challenging Stereotypes and Promoting Science in Schools: An Evaluation of the Researchers in Residence", *National Centre for Social Research*, **(2003)** 202-210.
- Yin, R.K.: "Case Study Research" *Design and Methods*, Beverly Hills, CA Sage, **(2004)** 456-489.
- Yuan-yuan, W.: "Analysis on Relationship and Difference between ISO9001 Standard and Six Sigma Management Method," *J. Electronics Quality*, **(2006)** 50-51.
- Yetiş, N.; Cebeci, Ö.Z.; Eyler M.A.; Kar, A.K.; Büyükdamgacı G.: "Kamu Sektörü Katagorisinde Türkiye'den İlk Bakış", *Marmara Üniversitesi Teknoloji Vakfı*, **(2002)** 113-118.
- http://en.wikipedia.org/wiki/Kano_model (August **2009**)
- <http://www.marmara.edu.tr/en/academic/faculties.pdf> (August **2009**)
- <http://fbe.marmara.edu.tr/websayfalari/mbabd/endustri.html> (August **2009**)
- http://www.adamssixsigma.com/six_sigma_approach.htm.(August **2009**)
- <http://www.pacepilot.com/sipoc1.shtml>(September **2009**)

<http://www.heart.nhs.uk/18weeks/images/sixsigma/table1.gif> (September **2009**)

<http://www.drugdiscoverytoday.com> (June **2009**)

<http://en.wikipedia.org/wiki/Ethnography> (June **2009**)

Http://Books.Google.Com.Tr/Books/Critical_To_Quality_Tree_Six_Sigma_For
(November, **2009**)

<Http://www.Library.Uiuc.Edu/Committee/Strategicplanning/Reports/Jan00report.Htm>
(January **2010**)

CURRICULUM VITAE

Sinem TUĞRAL KURULTAY was born in Çorlu, Tekirdağ in 1984. She applied Turkish Naval Academy after graduating Polatlı Anatolian High School in 2002. She graduated from Turkish Naval Academy in 2006. In the same year she admitted to Marmara University Industrial Engineering Department to start her graduate study. Her research interests are Six Sigma, Qualitative Analysis and improvement of education processes.

She has been working in Turkish Naval Forces for 3 years. She is currently working as a naval officer in naval warship.