QATAR UNIVERSITY

COLLEGE OF ENGINEERING

ADOPTING ENGINEERING STANDARDS FOR AN OIL & GAS (PETROLEUM) COMPANY USING BENCHMARKING & GAP ANALYSIS

BY

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ABSTRACT

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Title: Adopting Engineering Standards for an Oil & Gas (Petroleum) Company Using Benchmarking & Gap Analysis

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Engineering Standards are documents that provide the basis for common and repeated use the minimum meeting requirements of a system or equipment. Engineering Standards form the backbone of Oil & Gas industry and are used to ensure consistency, reduce cost and improve efficiency and effectiveness of the company. Thus to build and maintain plant facilities, the companies requires a standardization system (the process of developing and implementing engineering standards) which helps to maximize compatibility, interoperability, safety, repeatability and quality.

This study is based on a National Oil & Gas company (Company A) which used to have its own set of engineering standards and currently has an agreement with an International Oil company (Company B) for using their set of engineering standards. Since the agreement is expiring soon, Company A is in search of selecting the best option and is keen to study standardization and gaps from available options. In this study, the identities of companies are not being disclosed due to confidentiality clauses and instead the term Company A and Company B were used. The period taken to carry out this study was four months and it was carried out in Engineering Department of Company A.

The objective of this study is to capture evolution process regarding application of engineering standards till date in Company A which requires an understanding of the justifications for technical adoption of standards. It also requires analyzing different available options for Company A adoption and selecting the most viable option and finally developing an implementation guideline for Company A for selected option.

On expiry of the agreement, Company A has three viable options:

1. Use Company A or Company B standards on standalone basis
2. Renew its agreement with Company B
3. Develop a new set of company standards

The Methodology used was first to benchmark Company A against Company B, followed by carrying out a gap analysis between standards by preparing survey questionnaire to get acceptability of standards as per available options. The questionnaire was distributed to selected sample of engineers. Data was received from 51 respondents and was analyzed using statistical tools (SPSS & Excel). Based on the analysis results, an option was selected and an implementation guideline was developed for selected option.

After conducting this study, it can be concluded that option 1 can be removed since neither Company A nor Company B standards were complete and both had gaps. A detailed analysis was carried out on the remaining two options by using three kind of analysis: general, business & cost analysis. From these analyses, it was found that the second option was the best option for Company A and that was to renew the agreement with Company B for fulfilling its standards requirements. In the last part of the study, an implementation guideline for Company A has been developed for adoption of the selected option.

keywords: engineering standard, gap analysis, benchmarking, standard development, standards adoption, importance-satisfaction matrix, SPSS, radar chart.

Dedication

I would like to dedicate this project to Company A and standard section. Also, I would like to dedicate this project to my family and friends who helped me through my studies in Qatar University.

Acknowledgments

I would like to thank Almighty Allah as without His mercy, support and blessing, I wouldn't have completed my project and studies at Qatar University.

I would also like to thank all the people who helped me to do this project, firstly, profoundly thank Dr.Dinesh Seth for guiding me through the whole project and helping me in linking my research topic with the real life situations. I would like to extend special thanks to Dr.Galal for helping me in preparing the questionnaire and improve its quality.

Finally, I would like to thank my colleagues at work for providing me with the information required to do my project, their feedback on the questionnaire and shared their knowledge and experience on standards.

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List of Abbreviations

API: American Petroleum Institute

BSI: British Standards Institution

GSO: GCC Standardization Organization

ISO: International Organization for Standardization

QCS: Qatar Construction Specifications

SDO: Standards Development Organization

Std: Standard

SME: Subject Matter Experts

TDR: Technical Deviation Request

WD: Working Draft

Chapter 1: Introduction

1.1. Background and Motivation

Company A is one of the leading National companies which produces and exports Oil and Gas to different countries around the world. It manages various projects on its onshore and offshore locations. Since Oil and Gas projects generally involve high costs, along with taking care of highly sensitive safety, health and environment related issues, they need to be constructed and executed using the most efficient, effective and economic engineering practices i.e. the Standards. Engineering standards have been developed and are being maintained by various organizations at the International, Regional, National and Industry levels to cater to this requirement. Some of the types of standards commonly used are International Standards like ISO, IEC, BSI etc., Regional Standards like GSO, State of Qatar Regulations like QCS, National and Corporate Standards.

Company A had their own set of in house developed standards which were not updated or maintained for more than a decade. For this reason, the company entered into an agreement with Company B, one of the International Oil Companies for 10 years and is currently using engineering standards of Company B for executing their projects.

The agreement with Company B will expire within few years and Company A is trying to examine different options available for consideration after the expiration of the agreement.

Company A needs to develop a framework for Standardization practices to be followed in the post agreement scenario. This would mean that available options are identified and the most viable option is selected based on deep analysis through effective statistical tools. The selected option needs to be easily adaptable with regards to regional conditions, should have minimum implementation problems, and problems if encountered should be easily resolvable through established framework and the most important if the selected option is a change to the existing practices being used, it should have wide acceptability among its users.

1.2. Definition of Terms Related to this Project

1.2.1. Addendum

Addition, deletions and/or modifications to Company B standards that are prepared by working group to incorporate Company A technical requirements (Company A resource).

1.2.2. Benchmarking

Some of similar meaning definitions using different contexts are obtained for this term.

- Is the process of measuring or judging similar things against a certain level of excellence or standard.
- One of the Total Quality Management approaches that aims towards measuring organization`s operation, products and services against its competitors. It will lead to competitive advantage by establishing targets, priorities & operations.
- ‘Benchmark’ means a reference or measurement standard that is used in comparison. It is a continuous process for identifying, understanding and

adapting best practices and processes that will improve company`s performance.

The types of benchmarking are as follows:

1. Internal: where the company will compare between its operations and activities within the company.
2. Competitive: where the company will compare between itself and its competitor.
3. Functional: Where the company will compare its functions against other companies within the same industry.
4. Generic: where the company will compare its functions against other companies but not within the same industry (Oakland, 2001).

In this study, the term Company A refers to a national Oil & Gas Company while Company B refers to an international Oil & Gas Company . Due to confidentiality clauses, the identities of companies are not being disclosed.

1.2.3. Company A

The company is a leading national Oil & Gas company and has made an agreement with Company B for using its standards. It needs to identify the best option to adopt after the agreement ends.

1.2.4. Company B

The company is a leading international Oil & Gas company, that has an agreement with Company A and provides it with access to its standards. It also provides Company A with technical support when and as required.

1.2.5. Discipline

Engineering is a field that is divided into many disciplines such as mechanical, civil, electrical or chemical. Each discipline requires a deep understanding of certain skills and knowledge that should be gained in order to perform work in that discipline (Company A resource).

1.2.6. Engineering Standards

Documents that provide, for common and repeated use, the minimum requirements for items such as, but not limited to, material, equipment, design, procurement, construction, installation, commissioning & handover operation of a system or equipment. They shall be prepared by Working Group/Task Force and based on national/international standards, company`s specific requirements and latest market research. In this context, Engineering Standard can be, but not limited to Philosophy, Procedure, Recommended Practice, Specification or Guideline (Company A resource).

1.2.7. Gap Analysis

Gap analysis involves the comparison between actual performance and desired performance and then identifying gaps between them. European Foundation for Quality Management (EFQM) provides general key steps for conducting gap analysis and they are:

1. Data Collection
2. Conducing Assessment
3. Identifying strengths in the company and areas of improvement.

4. Develop action plan for improving
5. Review the plan and modify based on results obtained.

There are several ways for conducting gap analysis and they are:

1. Discussion groups
2. Surveys, questionnaire and interviews
3. Pro formas
4. Organization self-assessment matrix
5. Award Simulation
6. Audits
7. Hybrid approach (Oakland, 2001)

1.2.8. Standard

Document that provide the minimum required rules, guidelines, or characteristics for any activity. The purpose of standard is to ensure the optimal degree for certain activity. The standard is developed by reaching an agreement between different parties that were involved in the preparation process (ISO Guide 2, 2004).

1.2.9. Subject Matter Expert (SMEs)

The departmental Subject Matter Expert relative to a process; individual called upon by the users when there is any question regarding content or application that may arise from implementing the standard (Company A resource).

1.2.10. Working Group

Group of 5-9 members (representing various Departments who may be supported by external consultancy), who are assigned the responsibility of developing and maintaining standards on a specified generic topic group, requiring the involvement of either more than one discipline or more than one Department (Company A resource).

1.3. History of Standards

History shows that standards exist since the beginning of recorded history where some were created by royal decree like King Henry I for example, who created a standardized measurement called el, which was a measurement of his arm length. People were always looking for a standardized way to harmonize their activities with changing environment while others were created because of the increase in complexity of society in response to the needs.

Creation of calendar is one of the earliest examples of standardization where ancient people relied on moon, sun and star for identifying the appropriate time for harvesting the crops and celebrating different events.

Another important sector where standardization placed an important role is modes of transportation where the railroad gauge where standardized in order to make a uniform distance between two rails on a track.

When infrastructure become complex and cities became more sophisticated, development of national standards became a necessity in order to ensure safety of citizens (ANSI).

1.4. Importance of Standards

Oil & Gas industry involves the use various equipment, materials and methods in order to satisfy worldwide demands. Standardization become of great importance in today`s environment especially for Oil & Gas companies, equipment manufacturers and suppliers. The industry has realized both the tangible and intangible benefits of standardization. Standards are important because they ensure that the companies are operating safely and reliably. Standards ensure compliance to government requirements, equipment interchangeability and are providing procurement specifications which are significantly reducing the purchase and operating costs. Without proper standards all the above mentioned benefits can never be realized.

There is an increase in need of adopting management system standards such as ISO 9001 and ISO 14001 that helps in performing the activities in a structured way, therefore, developing technical standards for products is required in order to achieve ISO 9001 requirements.

Globally, SDOs are trying to relate legal and standardization requirements by developing standards that provide global requirements that are mentioned in laws. This will result in increasing the number of standards and countries obligation to use them (API & De Vries).

1.5. Problems with Current Standardization Practices

Some of the problems faced during standardization are

1. Developing a standardization system or set of standards to cater to the specific needs which would include:
   a. Identifying available options

    b. Choosing the right option
    c. Developing implementation guideline
    d. Providing for changes to accommodate conditions specific to climate, regulations, etc.
2. Maintenance of the established standards in-line with changing technology and other relevant factors.

1.6. Types of Standards

Each company develops its own kind of standards and classifies it according to its core business. Company A has the following types of Engineering Standards. The standards below were chosen based on ISO Directive, Part 2:

- International Standard: It is the standard that is developed by different SDOs and is internationally recognized. (ex: ISO, IEC).
- Regional Standard: It is the standard that is developed by different SDOs and is regionally recognized. (ex: GSO).
- National Standard: It is the standard that is developed by an SDO and is nationally recognized.(ex: QCS)
- Specification: Document prescribes a set of absolute technical requirements (that are objectively verifiable) to be fulfilled by a product / material, process, equipment or service.
- Guideline: Advisory document giving guidance in the form of non-mandatory principles or criteria guiding or directing technical activities applied across the Corporation.

- Procedure: Document describes a specific method of carrying out a particular technical task (e.g. inspection, testing, evaluation).
- Recommended Practice: Document that describes a recommended practice for different tasks (e.g. design, maintenance, operation, ..,etc)
- Philosophy: Top-level document gives mandatory principles and/or rules to be applied across the Corporation.
- Regulation: Document that describes the legal rules for a country.

1.7. Comparison between Engineering Standards and ISO 9001:2015

Table 1:

Comparison between Engineering Standard & ISO 9001:2015

	Engineering Standard	ISO 9001:2015
Scope	Sets out minimum requirements for operation of a system or equipment / process.	Sets out the requirements for a quality management system.
Purpose	Ensure consistency in operation	Ensure consistency in quality and that processes are fit for their purpose
Content	Different standard for every topic	Consists on seven main principles
Structure	Different structure for every topic	Has 10 clauses as per 2015 version
Certification	Certification is not necessary	Certification is necessary
Review Time	Long review time	Short review time

Resource: (ISO 9001:2015 and my own comparison)

1.8. Research Purpose & Significance:

The main objective of this study is to recommend for Company A the best option for engineering standards adoption. In order to recommend for Company A, different options were analyzed taking into consideration different engineering and management factors that might affect the decision. Identifying the standards to be used in designing and executing the projects is a very critical decision that has a direct impact on the company`s performance on a long term.

1.9. Research Objectives

The objectives of this study with reference to Company A were:

1. To carry out benchmarking & gap analysis on engineering standards between Company A and Company B.
2. To carry out detailed costing analysis to assess the suitability of various options that Company A can adopt.

1.10. Scope of Work

This research paper is about adopting engineering standards for Company A for the post agreement scenario. Currently, Company A is following Company B standards in designing its projects. This study covers the standards that are used to design engineering projects and it covers specifications and standard drawings only. The study was carried out in Engineering Department of Company A and the duration was four months.

1.11. Methodology & Framework Used

This study was conducted based on Xerox benchmarking which covered the following steps:

1. Define: the first step in benchmarking was to identify what is to be benchmarked and in this study, engineering standards of Company A was benchmarked against engineering standards of Company B. Standards that were related to the design was included in this study. In addition to that, the three options that were reviewed in this analysis were identified.
2. Measure: the second step of benchmarking is to determine the method that was used to collect data required for analysis. In this study, the data were collected by distributing a questionnaire to engineers who were familiar with both the company`s standards.
3. Analyze: In this step, and after obtaining the data from the questionnaire, the performance and acceptability level of both the company`s standards were identified by conducting a gap analysis to identify gap areas on both company`s standards. After conducting gap analysis, Importance Satisfaction matrices, Radar charts and detailed analysis (general, business and cost) were used to recommend for Company A the best option.
4. Improve: After identifying gap areas, the next step was to prepare an implementation guideline that will facilitate company`s adoption of the recommended option.
5. Check: The final step is to ensure that the selected option will satisfy Company`s A standards requirements and there were no more gaps identified.

The following figure (Figure 1) summarizes the main steps of benchmarking (Seth & Rastogi, 2009):

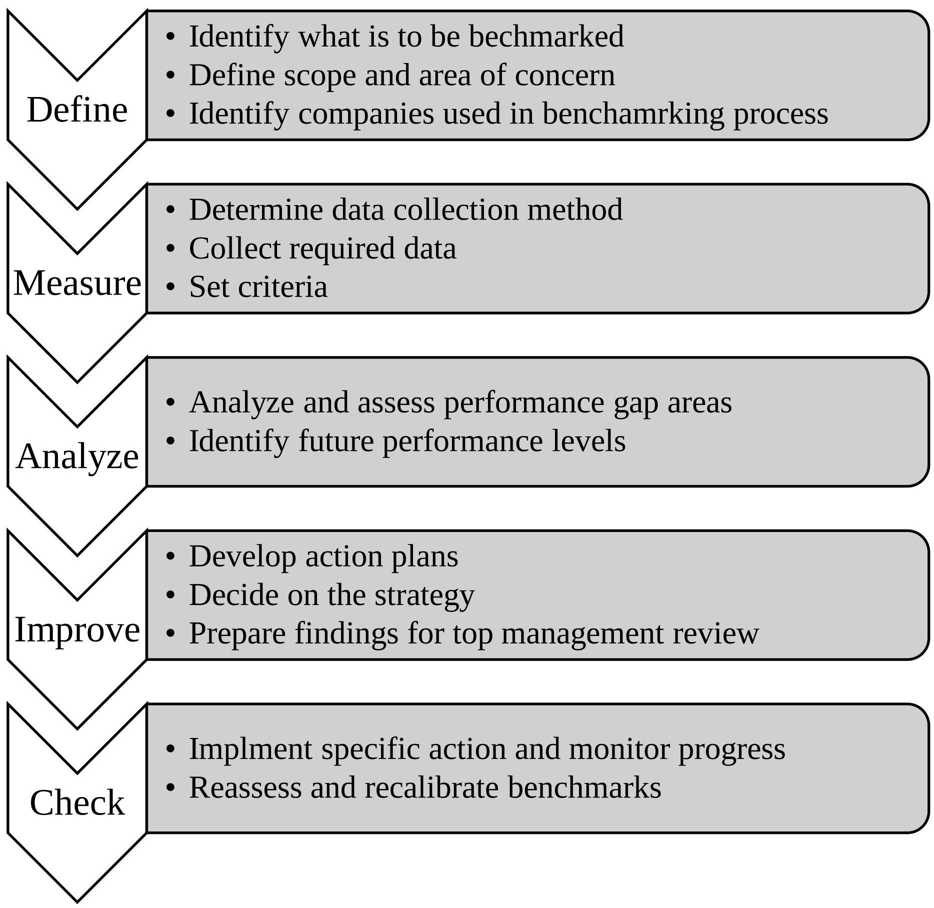

Figure 1. Major Processes in Benchmarking Process.

1.12. Process Flow

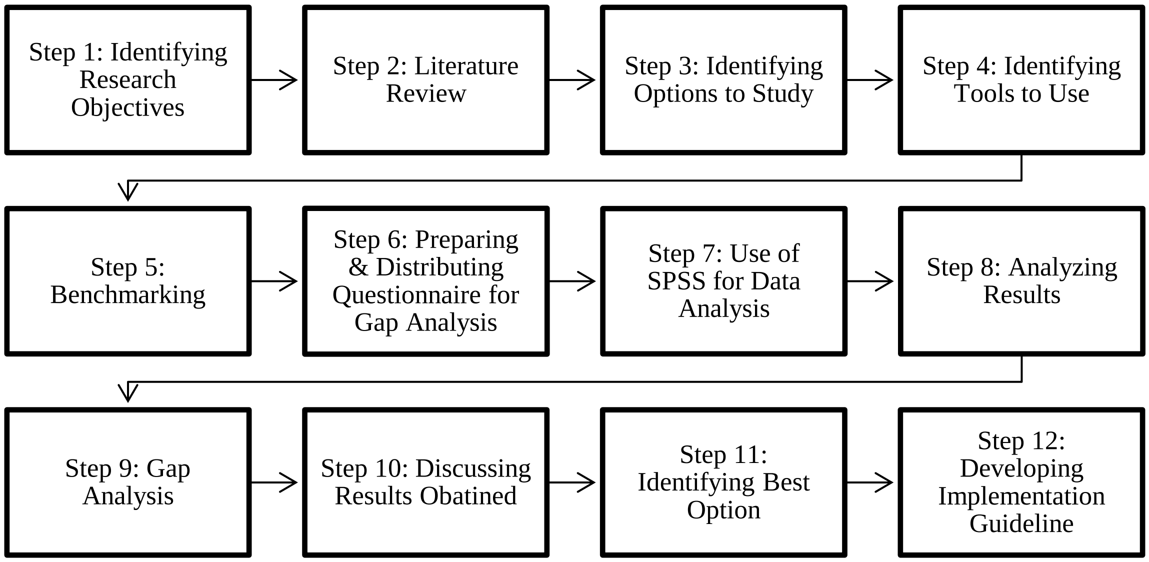

Figure 2. Process Flow for Research.

In order to conduct the study and arrive at the final recommendation for Company A, the following steps were followed:

1.12.1. Identifying Research Objectives

The main outcome of this study is to recommend for Company A the standardization system that should be adopted. Other objectives are discussed in section 1.9 above.

1.12.2. Literature Review

Different research papers were studied and reviewed in order to identify previous work that is related to standards development, applications on benchmarking and applications on Gap Analysis.

1.12.3. Identifying Options to Study

The following options were identified and studied:

a. Use Company A or Company B standards on standalone basis

b. Renew its agreement with Company B

c. Develop a new set of company standards

1.12.4. Identifying Tools to Use

After reviewing many research papers, benchmarking & gap analysis tools were identified to be used in this study.

1.12.5. Benchmarking

Engineering standards used for designing projects in Company A was chosen for analysis and Company B has been set as the Benchmark against which Company A will be assessed. A combination of Functional and Competitive type of benchmarking was used in the study.

1.12.6. Preparing & Distributing Questionnaire for Gap Analysis

Questionnaire was developed and distributed to collect engineer's acceptability of both companies' standards. The final questionnaire consisted of 5 parts. 51 responses were received from engineers and were included in the analysis.

1.12.7. Use of SPSS for Data Analysis

After distributing the questionnaire to selected sample, the data obtained were inserted into SPSS software to analyze it.

1.12.8. Analyzing Results

After obtaining required data, SPSS & Excel statistical software were used to analyze data. Several statistical tools and graphs were used to represent the data that was obtained.

1.12.9. Gap Analysis

Gap Analysis was carried out to identify the gaps between Company A and Company B standards using Radar Chart and Importance satisfaction Matrices.

1.12.10. Discussing Results Obtained

In this part, the results obtained were studied and discussed to arrive at the recommendation for Company A`s future plan of action.

1.12.11. Identifying Best Option

After discussing and studying the results obtained, the best option were identified.

1.12.12. Developing Implementation Guideline

After identifying the best option, a framework for this option was developed to identify the steps that the company should follow in order to fulfill its standards requirements.

1.13. Outline of the Project

This paper consists of eight main chapters. Chapter 1 is Introduction which provides a brief idea about Standards; what they are, why they are used, importance of standards, types of standards and problems associated with current standardization practices. Chapter 2 is the Literature Review where the results obtained from different papers were studied and analyzed. History of Engineering Standards in Company A is described in Chapter 3. Chapter 4 is dedicated to Primary Analysis. Chapter 5 is for User Response Analysis and Gap Analysis. Chapter 6 is for Discussion. Chapter 7 is related to Developing Implementation Guideline. Finally, Chapter 8 represents Conclusion, Limitations of the Study & Future Scope of Work.

Chapter 2: Literature Review

The purpose of this chapter is to discuss the literature review. It includes selected studies related to the topics of the study and classification of them into different areas.

2.1. Purpose, Details and Classification of Literature Review

This chapter discusses the various papers and studies that were referred to in order to conduct this study. It identifies what has been already done in Standards adoption field in order to have a theoretical background about the subject and several tools that can be used to conduct this study. Several papers related to standards development process, gap analysis and benchmarking were reviewed. A total of 37 useful resources were reviewed and studied. The major difficulty with this study is that there were no researches that is related to this field directly, instead, most of them were related to one specific standard and identifying the compliance percentage. Table 2 below illustrates the number of resources used in this study according to their type and Figure 3 shows the percentage distribution of those resources. Table 3 shows the areas covered in the resources and Figure 4 shows the distribution percentage of areas among those resources.

Table 2:

Statistics of Resources Used

Type of Resource	Number
Websites	1
Journal Papers	17
Conference Paper	3
Company A Resources	8
SDO Documents	6
Books	3

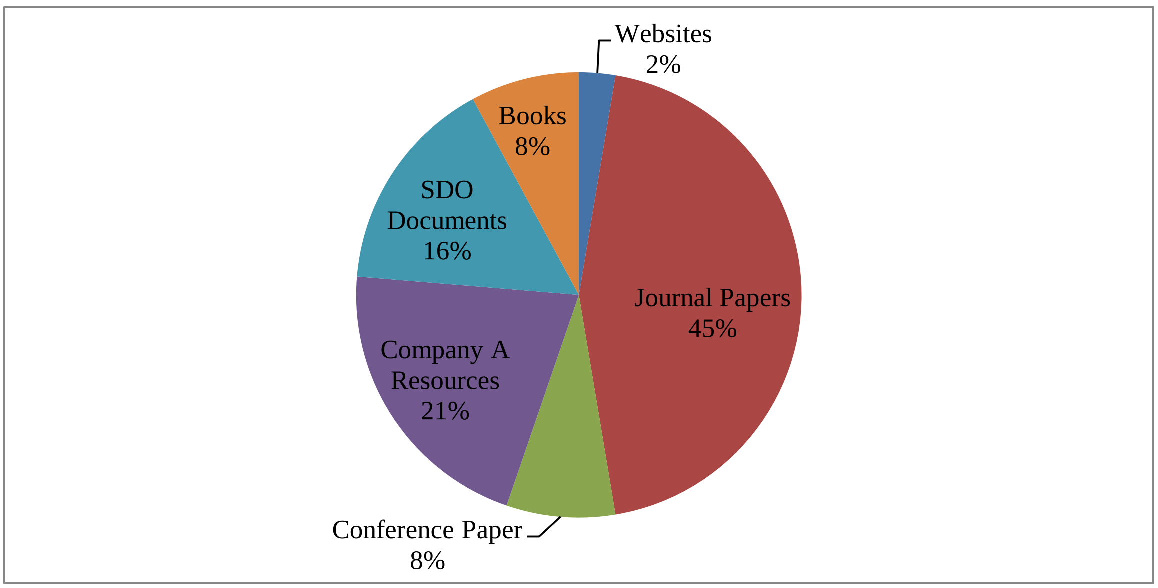

Figure 3. Percentage Distribution of Resources.

Table 3:

Statistics on Area of Resources

Area of Resource	Number
Gap Analysis	12
Benchmarking	5
API	2
BSI	1
ANSI	1
ISO Document	3
ISO Journal Papers	2
Books	3

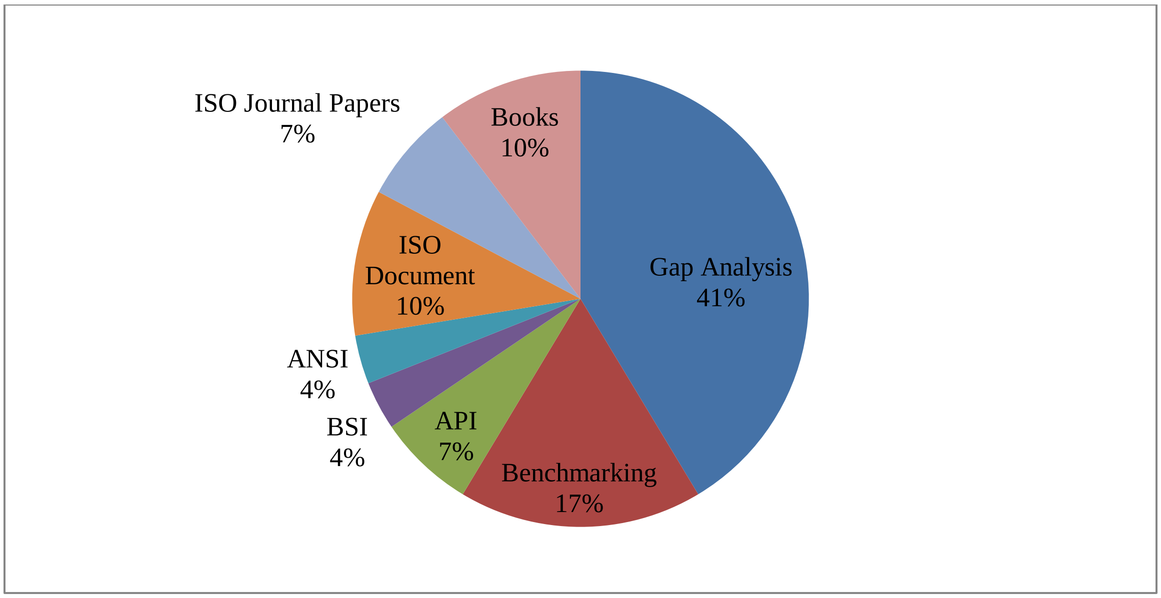

Figure 4. Percentage Distribution of Resources Based on Area.

2.2. Selected Resources for the Study

Table 4:

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
1	Through History with Standards	ANSI	Website	Describing history of standards	Descriptive website	Understanding history of standard	Used in History of Standards in Introduction.
2	Procedures for Standards Development	API	Document	Describe development process of API standards	Process	API development process for Standards	Used to understand API development Process
3	The Oil and Natural Gas Industry's Most Valuable Resource	API	Document	Describe importance of standard	Descriptive document	Understanding importance of standard	Used in importance of Standards in Introduction
4	Bridging the gap between systems and software engineering by using the SPES modeling framework as a general systems engineering philosophy	Wolfgang Böhm, Stefan Henkler, Frank Houdek, Andreas Vogelsang, Thorsten Weyer (2014)	Conference	Identify Gap between different engineering disciplines on the process of artifact in engineering embedded systems	SPES was used as an approach to link the gap between system engineering process standard ISO/IEC 15288 and the software engineering process standard ISO/IEC 12207	Consistency in systems was ensured and capabilities of tracing changes and performing automated analyses and transformations was enabled which therefore is going to lead to increase in efficiency & effectiveness.	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
5	Bridging the qualification gap between academia and industry in India	Lennart Büth, Vikrant Bhakar, Nitesh Sihag, Gerrit Posselt, Stefan Böhme, Kuldip Singh Sangwan, Christoph Herrmann (2017)	Conference	There is an increase in training requirements for graduate students and identified that there is a gap between academic education & industry requirements	- Interviews with industry professionals and literature review were used to collect data on graduate students and competency requirements in Industries to study the gap. - Learning Factory concept was introduced to cover this gap and tested at one of the Indian universities	- It was found that there is no gap in professional, personal & social but there is a gap in methodological competency. - It is expected that this proposed method will remove the gap and make the graduate engineers compete enough to enter the industry without further trainings.	Understandin g Gap Analysis tool and how it can be used
6	Benchmarking in construction industry	Deborah Fisher, Susan Miertschin, and David R. Pollock Jr (1995)	Journal	There is a lack in construction standards that can be used for benchmarking. Group was formed to benchmark construction industry.	Five tasks were identified by the group: determine the level of interest in benchmarking for people in the group, identify the activities to benchmark,	There is a tendency in overestimating the costs by 8% and underestimating the time (schedule) by 8% and change order are 11% of original cost.	Understandin g Benchmarkin g tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
					determine how to measure each activity that was identified, gather information and finally analyze information. Survey was sent to different companies to collect information about projects.		
7	Pocket Guide to Standards Development	BSI	Document	Describe development process of standards published by the BSI	Process and narrative document	BSI development process of Standards	Used to understand BSI standards development Process
8	ISO Directive Part 1:2012	ISO	Document	Describe development and maintenance process of international standards	Process and narrative document	ISO development process of Standards	Used to understand ISO standards development process

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
9	ISO Guide 2:2004	ISO	Document	Define terms and definitions used in standards development	Narrative document	A clear understanding of basic standards general terms and definitions.	Used in identifying types of standards
10	ISO 9001:2015 How to Use it	ISO	Document	How to use ISO 9001:2015	Narrative document	Major overview on ISO 9001:2015 document and how it is useful	Used in comparison between ISO and engineering standards
11	A quantitative method for ISO 17799 gap analysis	Bilge Karabacak, Ibrahim Sogukpinar (2006)	Journal	Evaluating compliance percentage to ISO/IEC 17799:2005, a standard that is used in information security sector different domains	Survey was used for evaluating company`s compliance to the standard that was applied and tested on one company	Survey Tool is a useful tool that gives accurate compliance results with minimum cost and time consumed. It is a unique tool that has useful features, very easy to use and is flexible.	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
12	Enhancing the effectiveness of benchmarking in manufacturing organizations	Sameer Kumar & Charu Chandra C. (2001)	Journal	Understanding similarities & difference between different benchmarking approaches that were used by different companies in order to identify the factors that have a great influence on benchmarking.	Telephone surveys & mails were used to gather the information from the companies	It was found that Function & Process is the best type of benchmarking while Strategic is the lowest. Organization culture, commitment by management and implementing benchmarking findings are three important factors that affect the effectiveness of the benchmarking	Understanding Benchmarking tool and how it can be used
13	A handbook of statistical analyses using SPSS	Sabine Landau and Brian S. Everitt (2004)	Book	Understand how to conduct statistical analyses using SPSS software	Descriptive document	Understanding how to use SPSS	Understanding how to use SPSS in data analysis

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
14	Benchmarking academic standards	Mike Laugharne (2002)	Journal	Benchmarked academic standards with quality assurance and identified ways for improving and enhancing the academic standards	Two ways for interpreting benchmarking was discussed: benchmarking & enhancement, and benchmarking & accountability.	The key challenge is obtaining collaboration between national agencies and higher education institute.	Understandin g Benchmarkin g tool and how it can be used
15	An analysis of the gap between the knowledge and skills learned in academic software engineering course projects and those required in real projects	Stephanie Ludi and James Collofello (2001)	Conferenc e	Identify whether there is a gap between engineering course and what is learned in real projects.	Software Engineering Body of Knowledge (SWEBOK) was used as a guide to identify the gap	SWEBOK was applied on one of the software engineering courses to test its effectiveness, and later general lessons learned that can be applied to other courses was presented. In addition to that, the authors also provided a novel approach that included larger projects in order to identify the gaps between courses and SWEBOK.	Understandin g Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
16	Total organizational excellence: Achieving world-class performance	John S. Oakland (2001)	Book	Set a framework for achieving world class performance	Descriptive document	Guides senior managers through the framework	Used in defining benchmarking and gap analysis in Introduction
17	Software engineering practices and Simulink: bridging the gap	Vera Pantelic, Steven Postma, Mark Lawford, Monika Jaskolka, Bennett Mackenzie, Alexandre Korobkine, Marc Bender, Jeff Ong, Gordon Marks and Alan Wassyng (2017)	Journal	There is an increase in training requirements for graduate students and identified that there is a gap between academic education & industry requirements	Interviews with industry professionals and literature review were used to collect data on graduate students and competency requirements in Industries to study the gap. The interview consisted of main four parts: professional, methodological, social & personal competency	It was found that there is no gap in professional, personal & social but there is a gap in methodological competency. Learning Factory concept was introduced to cover this gap and tested at one of the Indian universities. It is expected that this proposed method will remove the gap and make the graduate engineers compete enough to enter the industry without further trainings.	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
18	Implementing Engineering Asset Management Standards (PAS-55) in Information Management Evaluation: Case Study in Hong Kong	Peter W. Tse, Jingjing Zhong and Samuel Fung (2015)	Journal	Quality recognition in facility management companies in Hong Kong is very important and applying criteria's mentioned in PAS 55 standard is used to obtain this quality. An analysis was conducted to identify the compliance percentage of various asset management companies	Questionnaire was used to collect data from 30 commercial building where some of them were government owned and others were private owned. These buildings covers different uses that provide different services to the users	It was found that different buildings have different performance levels and that each building has its own strategy in implementing the standard. Also, it was found that that were a gap between significance level and standards adoption level and better performance companies will have higher standard adoption percentage with closely matched significance level	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
19	Building information modeling education for construction engineering and management. I: Industry requirements, state of the art, and gap analysis	R. Sacks and E. Pikas (2013)	Journal	Framework is required to be developed to describe how BMI can be incorporated in to university degree, what are the required topics, and achievement level required for every program.	Two steps were followed to develop this framework. The first step was identifying industry requirements using interviews, job advertisements, surveys and workshops. Based on those tools, 39 different industry requirements were identified and cognitive domain of Bloom`s taxonomy was used to identify targets for each competency. The second step was gap analysis. In this step, industry requirements were compared against state of art in leading universities.	A framework was completed and educators can use this framework to incorporate BMI into degree program requirements.	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
20	Building information modeling education for construction engineering and management. II: Procedures and implementation case study	E. Pikas, R. Sacks, and O. Hazzan (2013)	Journal	Apply framework that was developed on part I of the paper (No.19 above)	The framework was applied on four courses for three semesters	It was found that BMI should be introduced as an engineering tool for performing design, analysis, and management tasks in courses in addition to introducing it. Also, it was found that additional knowledge are also required such as knowledge on information sharing, knowledge management, qualified roles, etc. Finally, this framework can be applied by any educators who are looking to integrate BMI into the Construction Engineering and Management (CEM) program.	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
21	Performance benchmarking using interactive data envelopment analysis	Thierry Post and Jaap Spronk (1999)	Journal	Develop a procedure for performance benchmarking called Interactive Data Envelopment Analysis (IDEA)	Extended the use of Data Envelopment Analysis (DEA) performance technique and included Interactive Multiple Goal Programming (IMGP)	This procedure can be used by decision makers to identify feasible and desirable performance benchmarks. It can also be used to identify partners that will help in achieving performance standards. They believe that IDEA has a lot of advantages that will benefit the company and that it is better than normal industrial practices	Understanding Benchmarking tool and how it can be used
22	Performance measures of ISO 9001 certified and non-certified manufacturing companies	Evangelos Psomas and Dimitrios Kafetzopoulos (2014)	Journal	Make a financial and non-financial comparison between ISO 9001 certified and non-certified manufacturing companies	Questionnaire was used to collect companies performance measures on 140 Greek manufacturing	It was found that ISO 9001 certified companies have better performance compared to non-certified in terms of having better quality,	Used in Chapter 4 of the study to describe questionnaire development

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
					companies. Exploratory factor analysis was used to identify the latent factors of those performance measures. Different non-parametric tests were used to identify difference between certified and non-certified companies.	customer satisfaction and financial impact.	
23	ISO 9001 overall performance dimensions: an exploratory study	Evangelos Psomas and Angelos Pantouvakis (2015)	Journal	Validate and assess the performance dimensions reflecting ISO 9001 benefits for service companies and to identify relationships between performance dimensions	Questionnaire were used to collect data on performance dimensions of 198 ISO 9001:2008 Greek certified companies. Exploratory and Confirmatory factor analyses were used to analyze data obtained	It was found that there are main four performance dimensions and they were product/service quality, operational, financial and market.	Used in understanding how to conduct reliability of the questionnaire

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
24	Service quality: the gap in the Australian consulting engineering industry	Danny Samson and Rod Parker (1994)	Journal	Consulting engineering industries in Australia requires better understanding of their customers' needs and expectations to deliver their services in a better way	Service quality model were used to identify five gaps where some of them are related to service provider and the customer.	They found that there are gaps between services provided by service providers and customer expectations. It was identified that the gap was larger for architect service providers compared to government. In addition to that, the method that was used provided insights on how to understand industry gaps and improve company`s performance on those areas that are important to customers	Understandin g Gap Analysis tool and how it can be used
25	Reservoir systems analysis: closing gap between theory and practice	Slobodan P. Simonovi c (1992)	Journal	Provide ideas for closing the gap between theory and practice in reservoir	System analysis approach was used in decision making	It was found that there is a gap that exists between research studies and	Understandin g Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
				management		system approach application because of slow adaption of tools and techniques that are used in developing a quantitative basis for making decisions. The paper introduced two examples for closing that gap using mathematical models used in reservoir .The first example was a simulation optimization model that was used to illustrate how system approach can respond to needs in water resource engineering for reservoir sizing. The second model was selected to show how knowledge based technology can be used in water resource engineering	

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
26	An empirical analysis of critical factors of TQM: a proposed tool for self-assessment and benchmarking purposes	Thiagarajan, T., & Zairi, M. (1998)	Journal	Develop a tool that can be used for benchmarking and self-assessment	Survey was used to ask different companies to identify whether TQM factor is critical, important or minor importance	The paper identified that there are 22 critical factors that affects the effectiveness level of the Total Quality Management (TQM) implementation	Understanding Benchmarking tool and how it can be used
27	GAMBUSE: A gap analysis methodology for engineering SOA-based applications	Dinh Khoa Nguyen, Willem-Jan van den Heuvel, Mike P. Papazoglou, Valeria de Castro and Esperanza Marcos (2009)	Journal	Introduced a new model driven for business service engineering methodology called GAMBUSE (Gap Analysis Methodology for Business Service Engineering)	GAMBUSE is used to identify and conceptualize business services such that it can be processed while taking care of existing functionalities in exiting software assets	Based on this model the gap analysis is divided into six steps as follows: developing meta-model for as-is & to-be business processes, identifying boundaries around modelling elements for to-be model, identifying business services for to-be process model, identify the gaps, discrepancies & overlaps between the as-is and to-be models, create realization & reusability strategies and create business service blueprints.	Understanding Gap Analysis tool and how it can be used

Table 4 (Continued):

Selected Resources for the Study

SI. No.	Title of Paper	Author & Year	Type	Purpose	Methodology Used	Major Findings	How it was Useful
28	Towards total project quality: a gap analysis approach	Graham Winch, Aalia Usmani, & Andrew Edkins (1998)	Journal	Identified that existing approaches to project management & definition of project success have a problem as it is not identifying customers as the center of the process	Gap analysis model that is derived from service quality management was used to better understand problems in project management	The model was applied in Glaxo project as a case study and the results were successful. It was found that designs review is the principal negotiated order in quality of construction projects	Understanding Gap Analysis tool and how it can be used
29	Standardization: A business approach to the role of national standardization organizations	De Vries, H. J. (2013)	Book	Analyze national standardization organizations	Descriptive document	Understand standardization in general and national standardization in particular	Used in importance of Standards in Introduction

2.3. Gap Areas

The following gaps were identified after reviewing the above researches, books and journals:

- After referring to many studies, it is observed that no major work is reported in the Oil & Gas sector.
- A number of case studies are available discussing about benchmarking and gap analysis in marketing areas. Hardly, any study is available which covers engineering standards requirements.
- No study covers how the users respond to adequacy of standards.
- Most of the researches use single approach for comparison. No study used a combination approach.

Chapter 3: History of Engineering Standards in Company A

A brief exercise was carried out to study the history or evolution of engineering standards used by Company A for designing their projects over a period of time. Interviews were conducted with few engineers especially long serving employees (involved in standards) to understand how Company A had conducted its projects till date. This exercise was carried in order to understand and provide an insight to the technical decisions taken to arrive at the current engineering standards practices adopted by Company A to implement its projects.

The information collected from the conducted interviews and study of standards related archived documents can be summarized roughly into 3 phases. The findings regarding these 3 phases are recorded as below.

- **Phase I (From 1974 to 1999)**

In this phase, Company A`s projects were designed according to standards of Contractors executing the projects, in most of the cases these contractors were International Oil companies. The result was that different plants were designed and built as per different standards and in some cases, projects within the same plant was designed to different standards. Thus problems related to interchangeability, procurement, maintaining inventories and maintenance were common and at a peak. During this phase, some standards were developed by in-house technical teams as and when required but these were never revised or updated. The standardization system during this phase was at the lowest level.

- **Phase II (From 1999 to 2007)**

After the sudden oil price fluctuations experienced during the late 1990s, Company A gave a serious thought to establish the engineering standards system for implementing new projects, carrying out modifications in existing plants and eradicating problems faced during Phase 1.

Company A's management took a decision to develop its own set of standards to fulfill to its standardization requirements. For this purpose, a team of Subject Matter Experts (SMEs) were assigned firstly to prepare a master list of required standards and secondly to develop these identified standards in order to build company`s own set of standards. In a period of nearly 18 months, a set of major standards was developed. This set was not complete but nearly covered major engineering discipline requirements. During this phase Company A also awarded a Contract for supply of standards developed by International Standards Developing Organizations (SDOs). These standards were supplied by an external contractor in CDs and updates were provided at regular intervals. These standards were used as reference for the users to be updated with latest international practices and codes. Company A started designing and building its projects as per these available resources.

As part of international practice, every standard that is developed needs to be revised at least after 3-5 years of development. Unfortunately, this exercise took place only on random basis on certain standards for few disciplines. The main reason was that the system to maintain and control revisions did not exist. Thus, the standards became either obsolete or outdated. This led the company to the next phase of development process which is described in Phase III.

- **Phase III (From 2007 till date)**

For the purpose of minimizing the detrimental impacts of the approach used during Phase II and solve the problem of having non-maintained standards, a team was formed and was asked to assess the impact of acquiring Company B standards. The team did a thorough analysis and detailed study and contacted different functions/departments of the company to identify the advantages and disadvantages of acquiring Company B standards. The team found that there would be no negative impact on existing facilities of Company A by using Company B standards. Based on the team's recommendation, Company A signed the agreement with Company B and Company A is currently using Company B standards for its upcoming projects and carrying out modifications & upgrades to existing facilities using Company B standards as far as possible.

The problems faced during this phase were that no framework existed to accommodate regional climatic conditions and State regulations thus giving rise to deviation requests and thus additional work for the discipline SMEs. Secondly, although Company A's management had decided to use Company B as default engineering standards, there was no system to strictly implement the same. In certain recent projects, the list of standards given to contractors contained old standards as well. Also, the most important factor which was of concern was that most of the agreement period with Company B was through and few years remained for expiry. Thus, began the start of this research project.

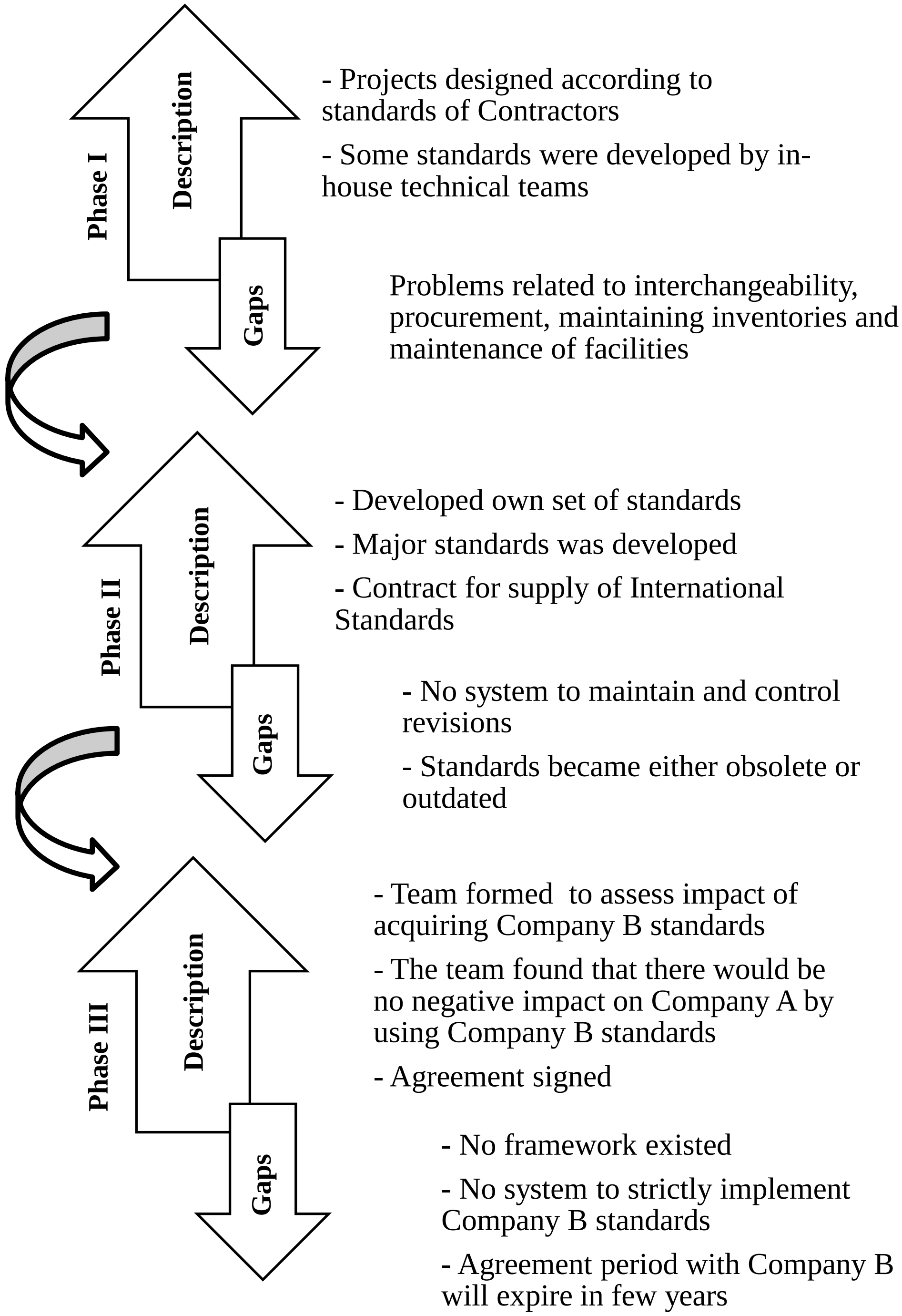

Figure 5. History of Engineering Standards in Company A.

Chapter 4: Primary Analysis

After identifying that Engineering standards of Company A was benchmarked against Company B, the preparation & distribution of questionnaire step was conducted. In this chapter, the development & distribution of questionnaire along with sample selection will be discussed. Also, various primary statistical tests will be discussed.

4.1. Development of Questionnaire

Questionnaire was used in conducting the research study in Company A. To develop the questionnaire, several research papers were analyzed to identify the three options that the company can adopt. The options that were analyzed are: use Company A or Company B on standalone basis, or renew license with Company B, or develop new company standards. The initial version of the questionnaire was sent to experts and managers to identify whether it captures the required objective and provide their recommendations to the questionnaire to improve the clarity and overall understanding of the questions. Also, Interviews & Delphi method was conducted to identify whether the factors that were chosen were able to capture acceptability of both companies' standards. Based on their recommendations, some of the questions were re-phrased to capture their feedback. The final questionnaire consisted of questions on general profiles of engineers and detailed questions on every option. Respondents were asked to evaluate every option using a five-point Likert Scale, where 1 represented "Lowest Scale" and 5 represented "Highest Scale".

The final factors that were considered in the questionnaire were:

1. Impact on Project Cost: How does the standard affects the project cost.
2. Accuracy: It is a measure of how the standard is being correct or precise.
3. Clarity: It is a measure of the standard state of being clear.
4. Correctness: It is a measure of the standard state of being free from error.
5. Completeness & Applicability: It is a measure of the standard state or condition of having all the necessary or appropriate parts. It also measures the quality of being relevant or appropriate.
6. Conforming to State Regulations: It is a measure of the standard conformance to Qatar State regulations.
7. Ease of Implementation: It is a measure to identify whether the standard can be easily implemented and used.
8. Require Training: It is a measure of identifying whether the standard requires training before using it.
9. Design Maturity: Represents the likelihood of quality problems that could potentially arise from the uniqueness of design.
10. Manufacturing Complexity: Represents the likelihood of quality problems that could potentially arise from the application of multiple fabrication steps or the use of particularly complex processes.
11. Heath, Safety & Environment (HSE): It is a measure to identify whether standard considers safety, health and environment issues.
12. Inspection & Certification: It is a measure to identify whether the standard captures the inspection part.

13. Maintaining Standard: It is measure of how often the standard is reviewed and updated.
14. Availability of Resources to Implement: It is a measure to identify whether resources can be easily located to implement the standard.
15. Familiarity with the Standard: It is a measure to identify whether being familiar with standard content is important and what is the level of satisfaction against two company`s standards.

4.2. Questionnaire Content

The final questionnaire consisted of five different parts as follows:

1. Part 1: Profile of the engineers.
2. Part 2: Identifying importance and satisfaction levels for Company A and Company B standards against 15 different factors.
3. Part 3: Assessing effectiveness of developing addendums to Company B standards. This part consisted of three questions.
4. Part 4: Collecting engineer's opinion on developing own company standards.
5. Part 5: General recommendation by engineers on the option to follow after the agreement with Company B ends.

The questionnaire that was sent to engineers is shown in Appendix A.

4.3. Distribution of the Questionnaire

Questionnaire was distributed based on selective sampling where specific engineers where selected to fill the questionnaire. Engineers who have used both the standards were targeted in order to get a complete overview on both the standards. Five main disciplines were involved in the analysis: Mechanical, Electrical, Civil, Instrumentation and Process. A total of 51 responses were received and analyzed.

4.4. Reliability of the Questionnaire

4.4.1. Test for Reliability of Instrument: Internal Consistency Method

Reliability analysis was used in order to identify the ability of the questionnaire to yield consistent measurements. One of the most used methods to assess internal consistency of the questionnaire is psychometric measures (Zhang et al. 2000) by calculating Cronbach's α coefficient.

After preparing the questionnaire, the Reliability of the questionnaire was tested for Part 2 of the questionnaire in order to identify whether the chosen factors reflects the importance and satisfaction levels of Company A and Company B standards or not. Also, the factors that affect development of addendum which is Part 3 of the questionnaire were tested in order to identify whether those factors really necessitate the development of addendum. The results obtained are shown in Table 5 below.

Table 5:

Reliability Statistics for Questionnaire

SI No.	Part	Cronbach's Alpha
1	Importance of factors	0.901
2	Satisfaction level of factors for Company A standards	0.954
3	Satisfaction level of factors for Company B standards	0.949
4	Influence level of the listed factors in necessitating the development of Addendum	0.635
5	Overall questionnaire	0.930

From Table 5, the following can be concluded about reliability of the questionnaire:

- For Importance of factors, the value was 0.901 which indicates that the selected factors reliability estimate the importance of the standards.
- For satisfaction level of factors for Company A standards, the value was 0.954 which indicates that the selected factors reliability estimate the satisfaction level of company`s A standards.
- For satisfaction level of factors for Company B standards, The value was 0.949 which indicates that the selected factors reliability estimate the satisfaction level of company`s B standards.
- For influence level of the listed factors in necessitating the development of addendum, the value was 0.635 which indicates that the selected factors

reliability estimate the reasons that necessitate the development of the addendum.

- The last value was for testing the reliability of the overall questionnaire. The value was 0.930 which indicates that the selected questions reliably estimate the overall objective of the questionnaire.

From the above results, the value of alpha for each part of the questionnaire and its overall is much higher than the minimum acceptance level of 0.6 (Nunnally, 1978) and thus it can be concluded that the questionnaire is reliable and the results that were obtained can be analyzed (Seth & Tripathi, 2005) (Seth & Shrivasta, 2016).

4.4.2. Test for Content Validity

A subjective and judgmental test on the content was done in order to identify whether the selected tool is a truly comprehensive measure of the area under stud (Nunnally, 1978). In this study, experts opinion was taken an hence it demonstrates content validity (Seth & Tripathi, 2005) (Seth & Shrivasta, 2016).

4.5. Normality Test

Many statistical tests require an assumption of having a normal distribution of the data. In general, there are two methods that can be used to test the normality of the data: graphically & numerically. In this study, Kolmogorov-Smirnov and Shapiro-Wilk test were used to test normality.

Table 6*:*

Test of Normality for Importance of Factors

SI No.	Factors	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
1	Cost	.230	51	.000	.836	51	.000
2	Accuracy	.278	51	.000	.683	51	.000
3	Clarity	.302	51	.000	.668	51	.000
4	Correctness	.290	51	.000	.676	51	.000
5	Completeness	.287	51	.000	.737	51	.000
6	Regulations	.377	51	.000	.667	51	.000
7	Implementation	.273	51	.000	.858	51	.000
8	Training	.287	51	.000	.839	51	.000
9	Design Maturity	.269	51	.000	.849	51	.000
10	Manufacturing Complexity	.228	51	.000	.901	51	.000
11	HSE	.329	51	.000	.725	51	.000
12	Inspection	.228	51	.000	.842	51	.000
13	Maintain Std	.286	51	.000	.798	51	.000
14	Resources	.208	51	.000	.858	51	.000
15	Familiarity	.245	51	.000	.837	51	.000

Table 7:

Test of Normality for Satisfaction Level of Company A

SI No.	Factor	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
1	Cost	.277	51	.000	.843	51	.000
2	Accuracy	.205	51	.000	.903	51	.001
3	Clarity	.206	51	.000	.882	51	.000
4	Correctness	.198	51	.000	.889	51	.000
5	Completeness	.204	51	.000	.900	51	.000
6	Regulations	.261	51	.000	.812	51	.000
7	Implementation	.238	51	.000	.890	51	.000

Table 7 (Continued):

Test of Normality for Satisfaction Level for Company A

SI No.	Factor	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
8	Training	.303	51	.000	.841	51	.000
9	Design Maturity	.233	51	.000	.874	51	.000
10	Manufacturing Complexity	.306	51	.000	.837	51	.000
11	HSE	.187	51	.000	.831	51	.000
12	Inspection	.211	51	.000	.881	51	.000
13	Maintain Std	.185	51	.000	.916	51	.001
14	Resources	.195	51	.000	.883	51	.000
15	Familiarity	.262	51	.000	.841	51	.000

Table 8:

Test of Normality for Satisfaction Level of Company B

SI No.	Factor	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
1	Cost	.222	51	.000	.881	51	.000
2	Accuracy	.284	51	.000	.847	51	.000
3	Clarity	.211	51	.000	.865	51	.000
4	Correctness	.312	51	.000	.786	51	.000
5	Completeness	.252	51	.000	.876	51	.000
6	Regulations	.246	51	.000	.893	51	.000
7	Implementation	.246	51	.000	.838	51	.000
8	Training	.272	51	.000	.876	51	.000
9	Design Maturity	.260	51	.000	.843	51	.000
10	Manufacturing Complexity	.286	51	.000	.846	51	.000
11	HSE	.269	51	.000	.785	51	.000
12	Inspection	.264	51	.000	.866	51	.000
13	Maintain Std	.260	51	.000	.798	51	.000

Table 8 (Continued):

Test of Normality for Satisfaction Level of Company B

SI No.	Factor	Kolmogorov- Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
14	Resources	.213	51	.000	.875	51	.000
15	Familiarity	.241	51	.000	.861	51	.000

Table 9:

Test of Normality for Factors Necessitating Addendum Development

SI. No.	Factor	Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
1	Regional Conditions	.282	51	.000	.797	51	.000
2	State Regulations	.342	51	.000	.716	51	.000
3	Lessons Learnt	.189	51	.000	.891	51	.000
4	TDR	.222	51	.000	.899	51	.000
5	Open Options	.252	51	.000	.881	51	.000

Shapiro-Wilk Test provides better results when the sample size is less than 50 but can still be used if the sample size does not exceed 2000. Since sample size used in this study was small, Shapiro-Wilk test was used to test normality. Based on this test, the data are considered normal is the significance level is greater than 0.05 while considered not normal if the significance level is less than 0.05. From Table 6,7,8 & 9 all values for Importance of Factors, Satisfaction level of Company A, Satisfaction level of Company B and factors for developing addendum were 0.000<0.05, which means that it can be concluded that the data are not normally distributed.

4.6. Test Homogeneity of Variances

Testing the homogeneity of variance in the data is required as a prerequisite for many statistical tests in order to identify whether population variances are equal for all groups. In this study, Levene test were used to test homogeneity.

Table 10:

Test of Homogeneity of Variance for Importance of Factors

SI No.	Factor	Levene Statistic	df1	df2	Sig.
1	Cost	2.425	4	46	.061
2	Accuracy	2.617	4	46	.047
3	Clarity	3.332	4	46	.018
4	Correctness	2.001	4	46	.110
5	Completeness	4.498	4	46	.004
6	Regulations	3.190	4	46	.021
7	Implementation	.553	4	46	.698
8	Training	5.437	4	46	.001
9	Design Maturity	1.452	4	46	.232
10	Manufacturing Complexity	.280	4	46	.889
11	HSE	5.572	4	46	.001
12	Inspection	1.449	4	46	.233
13	Maintain Std	.616	4	46	.653
14	Resources	2.413	4	46	.062
15	Familiarity	2.103	4	46	.096

Table 11:

Test of Homogeneity of Variance for Satisfaction Level of Company A

SI No.	Factor	Levene Statistic	df1	df2	Sig.
1	Cost	.853	4	46	.499
2	Accuracy	1.248	4	46	.304
3	Clarity	1.919	4	46	.123
4	Correctness	1.076	4	46	.379
5	Completeness	1.499	4	46	.218
6	Regulations	2.044	4	46	.104
7	Implementation	5.807	4	46	.001
8	Training	.269	4	46	.897
9	Design Maturity	1.349	4	46	.266
10	Manufacturing Complexity	.775	4	46	.547
11	HSE	2.047	4	46	.103
12	Inspection	.423	4	46	.791
13	Maintain Std	.935	4	46	.452
14	Resources	.362	4	46	.834
15	Familiarity	1.971	4	46	.115

Table 12:

Test of Homogeneity of Variance for Satisfaction Level of Company B

SI No.	Factor	Levene Statistic	df1	df2	Sig.
1	Cost	1.844	4	46	.137
2	Accuracy	5.030	4	46	.002
3	Clarity	1.442	4	46	.235
4	Correctness	.606	4	46	.660
5	Completeness	2.730	4	46	.040
6	Regulations	2.493	4	46	.056
7	Implementation	1.928	4	46	.122
8	Training	.381	4	46	.821
9	Design Maturity	2.413	4	46	.062

Table 12 (Continued):

Test of Homogeneity of Variance for Satisfaction Level of Company B

SI No.	Factor	Levene Statistic	df1	df2	Sig.
10	Manufacturing Complexity	.612	4	46	.656
11	HSE	1.405	4	46	.247
12	Inspection	.985	4	46	.425
13	Maintain Std	2.964	4	46	.029
14	Resources	1.251	4	46	.303
15	Familiarity	.373	4	46	.827

Table 13:

Test of Homogeneity for Factors Necessitating Developing Addendums

SI. No.	Factor	Levene Statistic	df1	df2	Sig.
1	Regional Conditions	1.398	4	46	.250
2	State Regulations	1.181	4	46	.332
3	Lessons Learnt	.901	4	46	.471
4	TDR	.892	4	46	.476
5	Open Options	3.333	4	46	.018

Based on Levene test, the sample is considered to have equal variance if the significance level is greater than 0.05 and not equal if the significance level is less than 0.05. From Table 10, 11, 12 & 13 the following can be concluded:

- Variances for importance of factors for Accuracy, Clarity, Completeness & Applicability, Conforming to State Regulations, Training and HSE factors were not equal.

- Variances for satisfaction level of Company A for Ease of Implementation factor were not equal.
- Variances for satisfaction level of Company B for Accuracy, Completeness & Applicability, and Maintaining the Standard factors were not equal.
- Variances for Closing open options of Company B standards factor was not equal.

Chapter 5: User Response Analysis and Gap Analysis

In this chapter, the user response data obtained from the questionnaire will be analyzed and presented in two parts: Descriptive and Analytical Parts.

5.1. Descriptive Part

Part 1

- *Description of the Questions:*

Part 1 contained general questions about the respondents. The questions were about: Discipline the engineer is working on, qualification level, in which discipline the respondent is qualified, total number of work experience, total number of work experience in Company A, extent of using Company A standards in the last 6 years, and extent of use of Company B standards in the last 6 years.

- *Results Obtained:*

The following figures represent the descriptive statistics of the sample involved in the analysis.

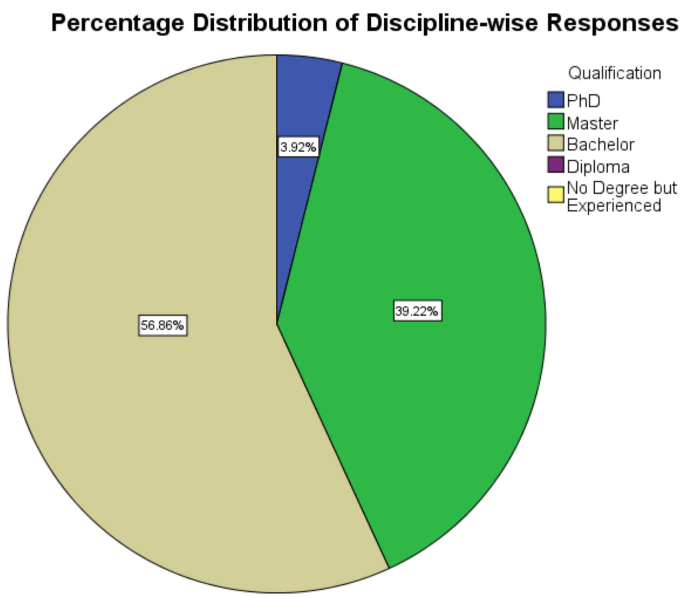

Figure 6. Percentage Distribution of Discipline-wise Responses.

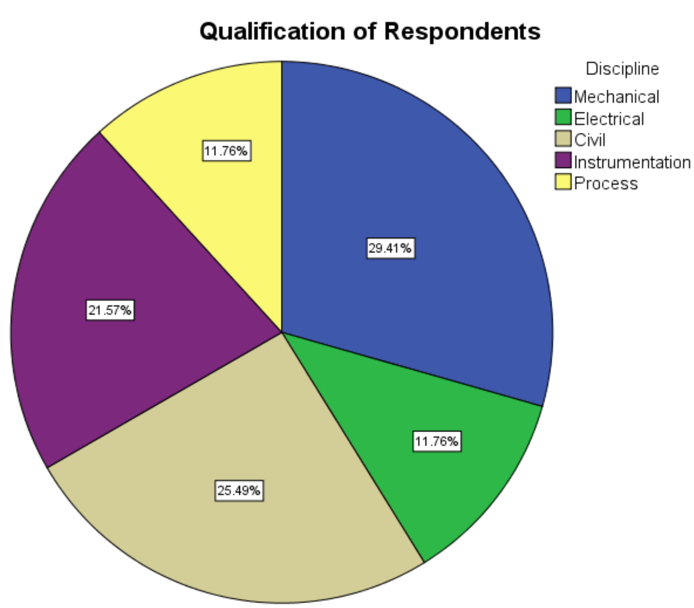

Figure 7. Qualification of Respondents.

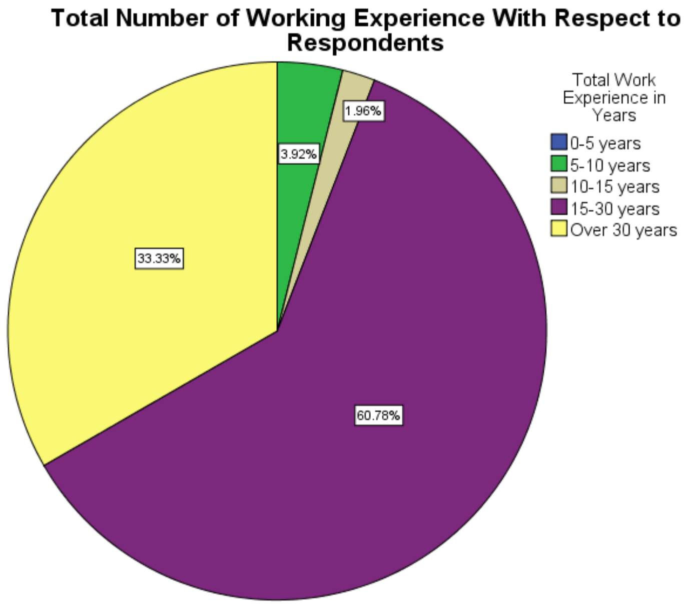

Figure 8. Total Number of Working Experience With Respect to Respondents.

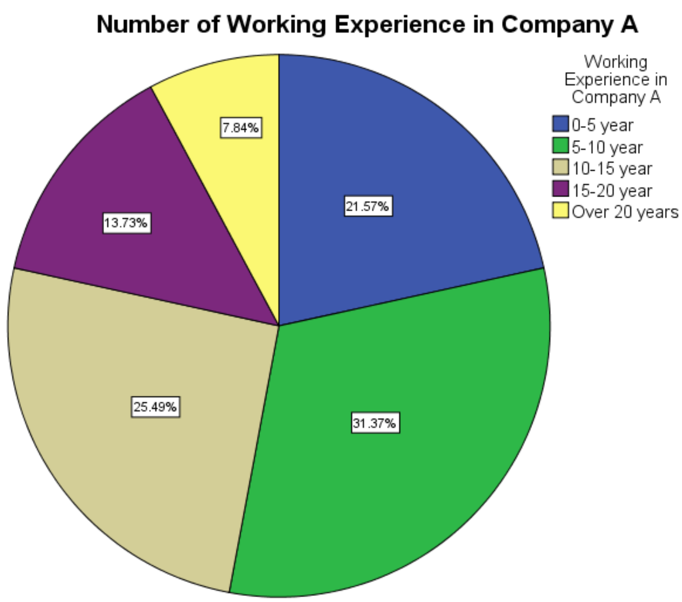

Figure 9. Number of Working Experience in Company A.

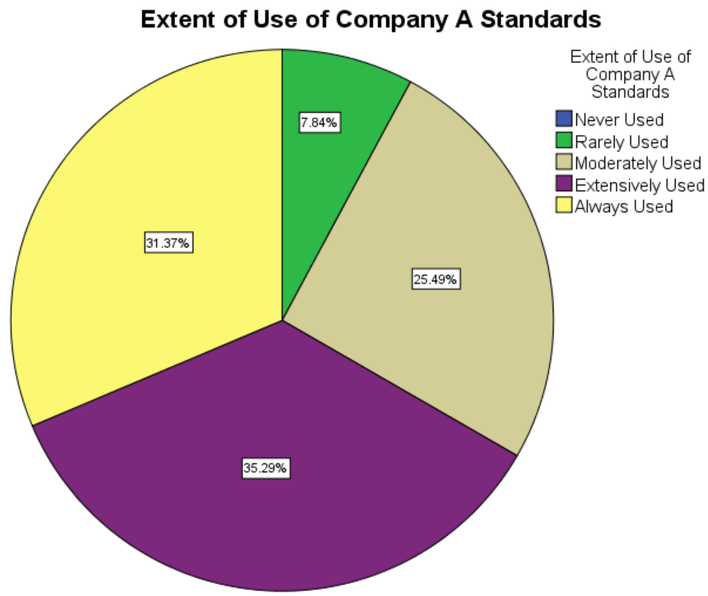

Figure 10. Extent of Use of Company A Standards.

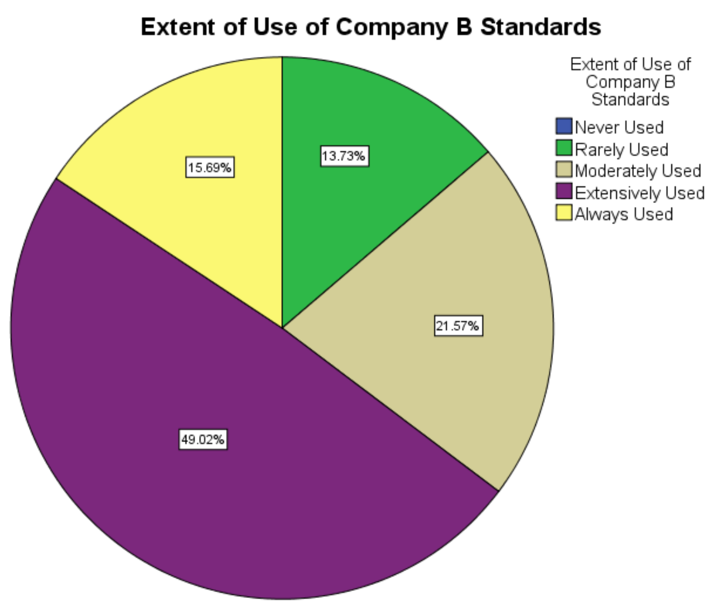

Figure 11. Extent of Use of Company B Standards

From the above figures (Figure 6, 7, 8, 9, 10 & 11) the following can be concluded:

- Most of the engineers were from Mechanical discipline representing 29.4% of the responses, followed by Civil with a percentage of 25.5% and then Instrumentation representing 21.6 % of the responses. Process & Electrical had exactly the same percentage of 11.8% respectively.
- Most of the engineers who filled the survey had a Bachelor degree qualification. The number was 29 out of 51 which is more than half of the sample and it accounted for 56.9% of the responses. 20 engineers had a Master degree and 2 had PhD representing 39.2% and 3.9% of the responses respectively.
- The engineers who filled the questionnaire had a great experience where 94.1% of the sample had an experience of over 15 years. On the other hand, about 21.5% of the engineers worked in Company A above 15 years. Most of the engineers had 5-10 years of working experience with Company A representing 31.4% of the sample followed by 25.5% of 10-15 years of working experience.
- Both Company A and Company B standards were used extensively representing 35.3% and 49% of the responses respectively. In addition to that, both companies had the lower percentage with rarely used with a percentage of 7.8% & 13.7 % respectively.

Part 2

- *Description of Questions:*

Part 2 was about identifying the importance level of 15 factors by rating them using a five-point Likert Scale, where 1 represented "Low Importance" and 5 "High Importance". In the same question, engineers were asked to identify satisfaction level against the same 15 factors for Company A and Company B standards. Five-point Likert Scale was also used where 1 represented "Low Satisfaction" and 5 "High Satisfaction"

- *Results Obtained:*
    - *Descriptive Statistics*

Table 14:

Descriptive Statistics for Importance of Factors

SI. No.	Factor	N	Range	Minimum	Maximum	Mean	Std. Deviation
1	Cost	51	4	1	5	3.78	1.026
2	Accuracy	51	4	1	5	4.33	.909
3	Clarity	51	4	1	5	4.37	.916
4	Correctness	51	4	1	5	4.35	.913
5	Completeness	51	4	1	5	4.25	.977
6	Regulations	51	4	1	5	4.33	1.089
7	Implementation	51	4	1	5	3.84	.925
8	Training	51	4	1	5	3.12	.840
9	Design Maturity	51	4	1	5	3.90	.900

Table 14 (Continued):

Descriptive Statistics for Importance of Factors

SI. No.	Factor	N	Range	Mini-mum	Maxi-mum	Mean	Std. Deviation
10	Manufacturing Complexity	51	4	1	5	3.27	1.078
11	HSE	51	4	1	5	4.25	1.055
12	Inspection	51	4	1	5	3.92	1.017
13	Maintain Std	51	3	2	5	4.20	.895
14	Resources	51	3	2	5	3.90	.944
15	Familiarity	51	4	1	5	4.00	.894

From Table 14 it can be concluded that Clarity had the highest important level of 4.37 & Training had the lowest importance level of 3.12. In general, all the factors had a mean above 2.5 which means that all the factors are important. Importance level of factors can be divided in to three categories. The first category covers factors that had a mean above 4.33. Four factors had a mean importance level above 4.33. These factors are: Clarity, Correctness, Accuracy and Conforming to State Regulations. The second category covers factors that had a mean between 4 & below 4.33. Four factors were identified in this category and they are: Completeness & Applicability, Health, Safety & Environment, Maintaining Standard and Familiarity with the Standard. The third category covers the factors that had a mean below 4. This category covers the rest of the factors and they were: Inspection & Certification, Design Maturity, Availability of Resources to Implement, Ease of Implementation, Impact on Project Cost, Manufacturing Complexity & Training.

Table 15:

Descriptive Statistics for Satisfaction Level of Company A Standards

SI No.	Factor	N	Range	Mini-mum	Maxi-mum	Mean	Std. Deviation
1	Cost	51	4	1	5	3.39	.896
2	Accuracy	51	4	1	5	3.41	1.023
3	Clarity	51	4	1	5	3.47	1.027
4	Correctness	51	4	1	5	3.47	.966
5	Completeness	51	4	1	5	3.35	1.036
6	Regulations	51	4	1	5	4.06	1.008
7	Implementation	51	4	1	5	3.59	.942
8	Training	51	4	1	5	3.10	.985
9	Design Maturity	51	4	1	5	3.31	.948
10	Manufacturing Complexity	51	4	1	5	3.08	.845
11	HSE	51	4	1	5	3.78	1.154
12	Inspection	51	4	1	5	3.51	.967
13	Maintain Std	51	4	1	5	2.78	1.101
14	Resources	51	4	1	5	3.51	1.046
15	Familiarity	51	4	1	5	3.71	1.006

Table 15 shows the satisfaction level of Company A Standards. Most of the factors mean satisfaction level was between 3.0 to 3.8. 13 factors were identified and they are: Health, Safety & Environment, Familiarity with the Standard, Ease of Implementation, Inspection & Certification, Availability of Resources to Implement, Clarity, Correctness, Accuracy, Impact on Project Cost, Completeness & Applicability, Design Maturity, Training & Manufacturing Complexity. Conforming to State Regulations had the highest mean satisfaction level of 4.06 while Maintaining Standard had the lowest satisfaction level of 2.78.

Table 16:

Descriptive Statistics for Satisfaction Level of Company B Standards

SI No.	Factors	N	Range	Minimum	Maxi-mum	Mean	Std. Deviation
1	Cost	51	4	1	5	3.35	.976
2	Accuracy	51	4	1	5	3.80	1.000
3	Clarity	51	4	1	5	3.78	1.026
4	Correctness	51	4	1	5	3.98	.927
5	Completeness	51	4	1	5	3.35	.996
6	Regulations	51	4	1	5	2.86	.917
7	Implementation	51	4	1	5	3.45	1.064
8	Training	51	4	1	5	2.98	1.010
9	Design Maturity	51	4	1	5	3.82	.953
10	Manufacturing Complexity	51	4	1	5	3.31	.883
11	HSE	51	4	1	5	4.04	1.148
12	Inspection	51	4	1	5	3.75	1.036
13	Maintain Std	51	4	1	5	4.08	1.055
14	Resources	51	4	1	5	3.43	.985
15	Familiarity	51	4	1	5	3.59	.920

Table 16 shows the satisfaction level of Company B standards. Maintaining Standard & Health, Safety & Environment had the highest mean satisfaction level of 4.08 & 4.04 respectively. On the other hand, Training & Conforming to State Regulations had the lowest satisfaction level of 2.98 & 2.86 respectively. Conforming to State Regulations was the highest in Company A while for Company B it is the lowest. On the other hand, Maintaining the Standard had the lowest satisfaction level for Company A while it is the highest in Company B. The rest of the factors had a mean between 3.31 & 3.98 and they are: Correctness, Design Maturity, Accuracy, Clarity, Inspection & Certification, Familiarity with the Standard, Ease of Implementation, Availability of Resources to Implement, Impact on Project Cost, Completeness & Applicability and Manufacturing Complexity.

- *Kruskal-Wallis H Test*

In order to identify whether there is a statistical difference between disciplines involved in the study, Kruskal-Wallis H Test was used. It is a non-parametric test that can be used when the assumption of normality and variance homogeneity are violated. Other assumptions required to use this test are mentioned below:

- The variable that is measured should be a dependent variable that can be measured on an ordinal scale and in this study 5 point Likert scale was used and so the assumption of ordinal level was satisfied.
- The number of groups used to conduct the test should be more than two and in this study, five independent groups were used based on discipline and they were: Mechanical, Electrical, Civil, Instrumentation and Process.
- There should be no relation between groups used in the study. It is assumed that this assumption is satisfied since questionnaire was distributed to different engineers who have no relation to each other and they were from different disciplines.

Since all of the above assumptions were satisfied, Kruskal-Wallis H Test was used to identify whether there is a statistical difference in mean between disciplines & importance level, discipline & satisfaction level of Company A and discipline & of

Company B. The results obtained are shown in Table 17, 18 & 19 below.

Table 17:

Kruskal - Wallis Test for Importance of Factors

SI No.	Factor	Chi-Square	df	Asymp. Sig.
1	Cost	10.829	4	0.029
2	Accuracy	8.102	4	0.088
3	Clarity	8.040	4	0.090
4	Correctness	5.950	4	0.203
5	Completeness	3.697	4	0.449
6	Inspection	18.730	4	0.001
7	Regulations	1.920	4	0.750
8	Implementation	9.842	4	0.043
9	Training	13.897	4	0.008
10	Design Maturity	3.152	4	0.533
11	Manufacturing Complexity	3.859	4	0.425
12	HSE	11.730	4	0.019
13	Maintain Std	9.025	4	0.060
14	Resources	9.497	4	0.050
15	Familiarity	7.688	4	0.104

Table 18:

Kruskal- Wallis H Test for Satisfaction Level of Company A

SI No.	Factor	Chi-Square	df	Asymp. Sig.
1	Cost	4.346	4	0.361
2	Accuracy	2.475	4	0.649
3	Clarity	2.179	4	0.703
4	Correctness	2.949	4	0.566
5	Completeness	6.817	4	0.146
6	Regulations	2.140	4	0.710
7	Implementation	6.362	4	0.174
8	Training	4.868	4	0.301

Table 18 (Continued):

Kruskal-Wallis H Test for Satisfaction Level of Company A

SI No.	Factor	Chi-Square	df	Asymp. Sig.
9	Design Maturity	8.808	4	0.066
10	Manufacturing Complexity	4.538	4	0.338
11	HSE	2.018	4	0.732
12	Inspection	6.887	4	0.142
13	Maintain Std	7.380	4	0.117
14	Resources	2.197	4	0.700
15	Familiarity	5.588	4	0.232

Table 19:

Kruskal - Wallis H Test for Satisfaction Level of Company B

SI No.	Factor	Chi-Square	df	Asymp. Sig.
1	Cost	10.166	4	0.038
2	Accuracy	4.255	4	0.373
3	Clarity	6.060	4	0.195
4	Correctness	3.737	4	0.443
5	Completeness	13.006	4	0.011
6	Regulations	9.198	4	0.056
7	Implementation	11.283	4	0.024
8	Training	6.344	4	0.175
9	Design Maturity	3.405	4	0.492
10	Manufacturing Complexity	6.202	4	0.185
11	HSE	5.528	4	0.237
12	Inspection	9.712	4	0.046
13	Maintain Std	2.937	4	0.568
14	Resources	5.196	4	0.268
15	Familiarity	6.869	4	0.143

From Kruskal – Wallis H Test results shown above (Table 17, 18 and 19) and detailed results of this test shown in Appendix C, the following can be concluded:

- There was a statistical significance difference between disciplines and importance of Impact on Project Cost, Inspection & Certification, Ease of Implementation, Training and HSE factors.
- There was no statistically significant difference in satisfaction level of Company A for all factors between the different disciplines. For all factors, p “Asymp. Sig.” was greater than 0.05.
- There was a statistical significant difference between disciplines and satisfaction level of Company B standards for Impact on Project Cost, Completeness & Applicability, Inspection & Certification and Ease of Implementation factors.

In order to identify which discipline really differs, Post Doc Pairwise Comparison analysis was conducted. From Appendix C, the following can be concluded:

- For Importance of factors:
    - Impact on Project Cost factor: There was a statistical difference between Civil & Electrical discipline (0.017<0.05).
    - Ease of Implementation Factor: There was a statistical difference between Civil & Instrumentation discipline (0.034<0.05).
    - Training Factor: There was a statistical difference between Instrumentation & Mechanical discipline (0.023<0.05) and Civil & Mechanical discipline (0.024<0.05).

- Training Factor: There was a statistical difference between Instrumentation & Mechanical discipline (0.023<0.05) and Civil & Mechanical discipline (0.024<0.05).
- Pairwise Comparison for HSE factor didn't show which discipline really differs.
- Inspection & Certification Factor: There was a statistical difference between Instrumentation & Mechanical discipline (0.003<0.05) and Instrumentation & Electrical discipline (0.021<0.05).
- Availability of Resources to Implement Factor: There was a statistical difference between Instrumentation & Mechanical discipline (0.044<0.05)

- For Satisfaction Level of factors for Company B:
  - Impact on Project Cost factor: There was a statistical difference between Civil & Electrical discipline (0.030<0.05).
  - Completeness & Applicability Factor: There was a statistical difference between Civil & Mechanical discipline (0.015<0.05).
  - Ease of Implementation Factor: There was a statistical difference between Civil & Mechanical discipline (0.032<0.05).
  - Pairwise Comparison for Inspection & Certification factor didn't show which discipline really differs.

Part 3

- *Description of Questions:*

Part 3 was about identifying the effectiveness level of developing addendum to Company B standards. This part consisted of three questions. The first question was about identifying whether developing addendum is necessary & effective tool by choosing between yes or no. The second question was related to the factors that necessitate the development of addendum. In this question, the engineer were asked to identify the influence level of these factor in necessitating an addendum using a five-point Likert Scale, where 1 represented "No Influence" and 5 "Always Influence". The third question was about identifying whether development of addendum effectively satisfy Company`s A requirements using a five-point Likert Scale, where 1 represented "Least Effective" and 5 "Very Effective".

- *Results Obtained:*

Part 3 (Question A: Addendum Necessity)

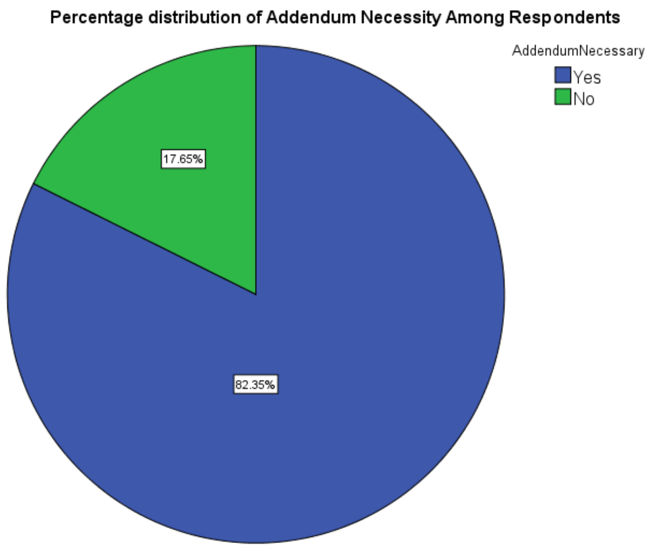

Figure 12. Percentage Distribution of Addendum Necessity among Respondents.

From Figure 12 it can be clearly concluded that developing Addendum is a necessary & Effective tool.

<u>Part 3 (Question B: Influence Level of factors the necessitate development of Addendum)</u>

Table 20:

Descriptive Statistics for Influence Level of Factors Affecting Addendum Development

		Regional Develop	State Develop	Lessons Learnt Develop	TDR Develop	Open Options Develop
N	Valid	51	51	51	51	51
	Missing	0	0	0	0	0
Mean		4.18	4.33	3.65	3.22	3.49
Median		4.00	5.00	4.00	3.00	3.00
Mode		5	5	3	3	3

Table 20 (Continued):

Descriptive Statistics for Influence Level of Factors Affecting Addendum Development

		Regional Develop	State Develop	Lessons Learnt Develop	TDR Develop	Open Options Develop
Std. Deviation		.932	.973	1.016	1.045	1.027
Variance		.868	.947	1.033	1.093	1.055
Range		3	4	4	4	4
Minimum		2	1	1	1	1
Maximum		5	5	5	5	5
Sum		213	221	186	164	178
Percentiles	25	4.00	4.00	3.00	3.00	3.00
	50	4.00	5.00	4.00	3.00	3.00
	75	5.00	5.00	4.00	4.00	4.00

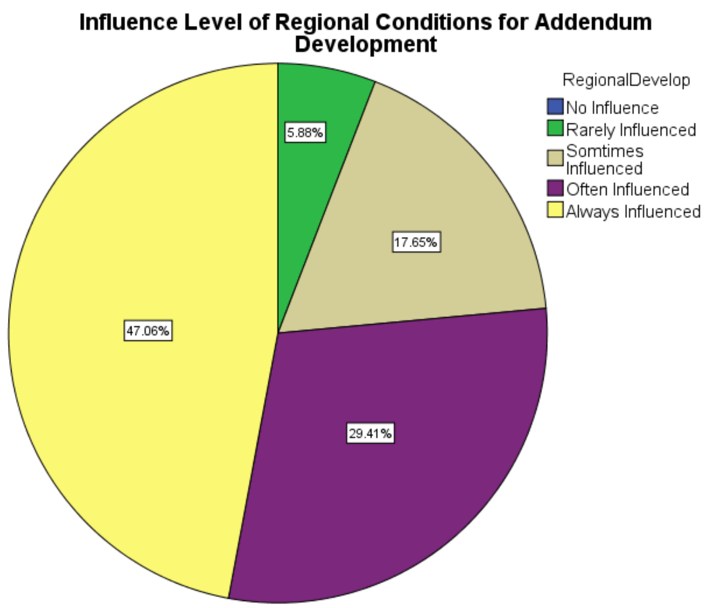

Figure 13. Influence Level of Regional Conditions on Addendum Development.

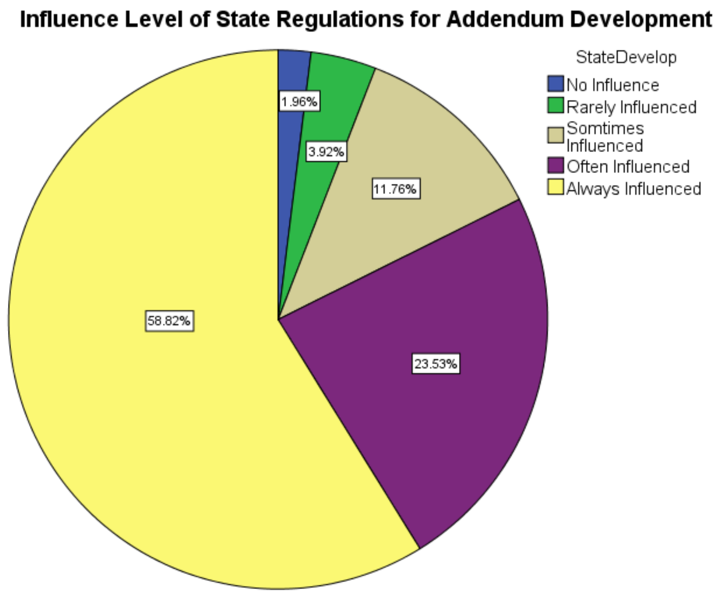

Figure 14. Influence Level of State Regulations on Addendum Development

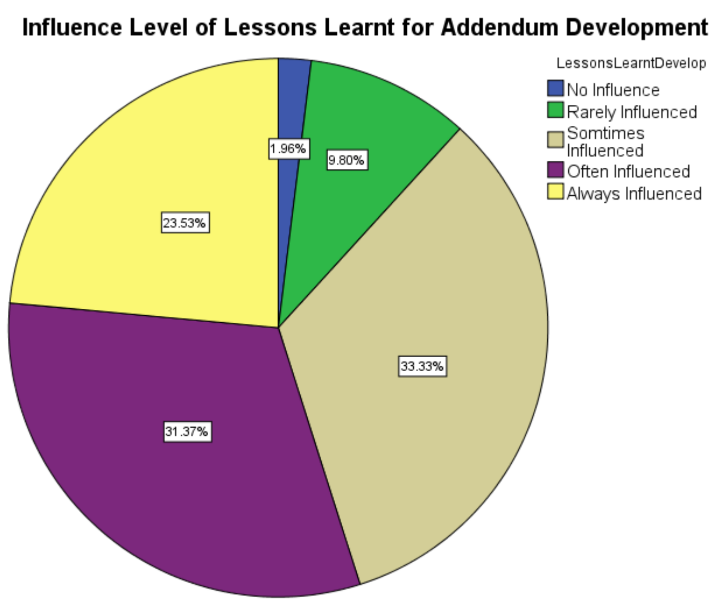

Figure 15. Influence Level of Lessons Learnt on Addendum Development.

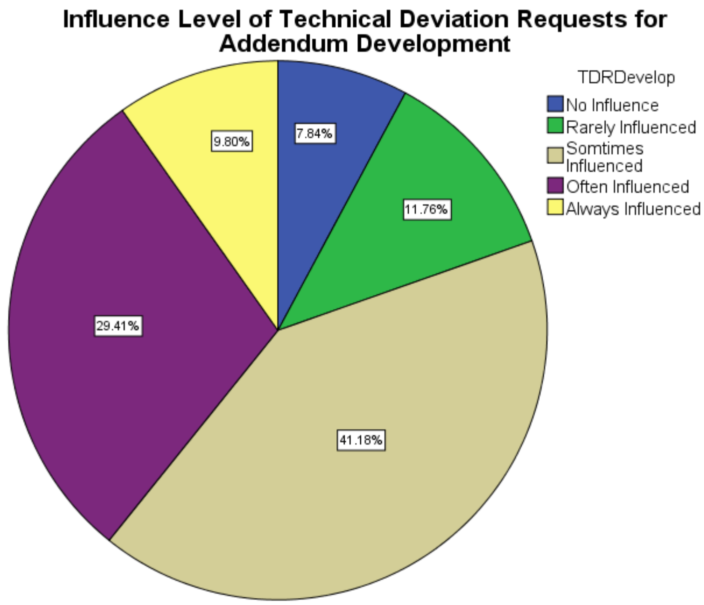

Figure 16. Influence Level of TDR on Addendum Development.

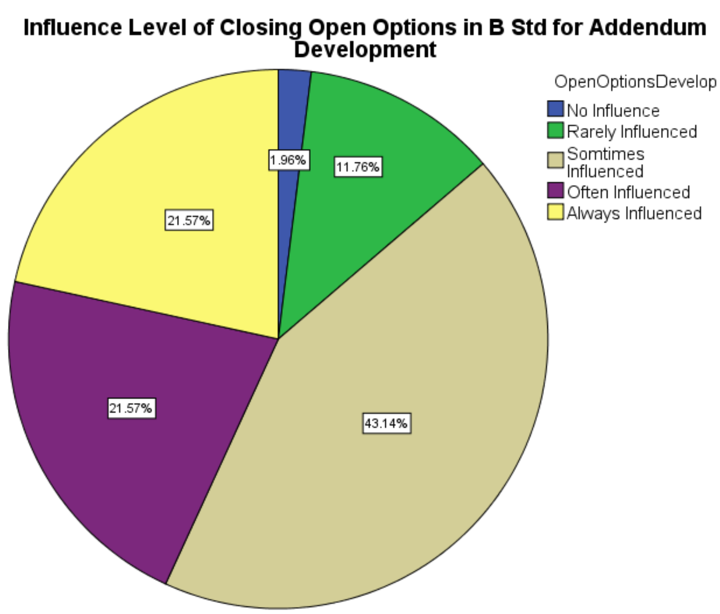

Figure 17. Influence Level of Closing Open Options in B Std on Addendum Development.

From Figure 13 to Figure 17 it can be clearly concluded that Regional/ Climatic Conditions & State/Corporate Regulations are very important influencers that necessitate the development of Addendum. Almost all of the responses that were analyzed identified the influence level as either “Always Influence” or “Often Influence” or “Sometimes Influence” with a percentage of 94.1% for both reasons. Developing addendum because of the Lessons Learnt had the most percentage in “Sometimes Influence” representing 33.3% followed by “Often Influence” and then “Always Influence” with a percentage of 31.4% and 23.5% respectively. Most of the engineers identified the influence level of Technical Deviation Requests as “Sometimes Influence” with a percentage of 41.2% followed by “Often Influence” with a percentage of 29.4%. The last factor which is Developing addendum in order to close open options in Company B standards had the highest percentage with “Sometimes Influence” representing 43.1%. “Often Influence” & “Always Influence” had the same percentage which is 21.6%.

Part 3(Question C: Addendum Satisfy Company A requirements)

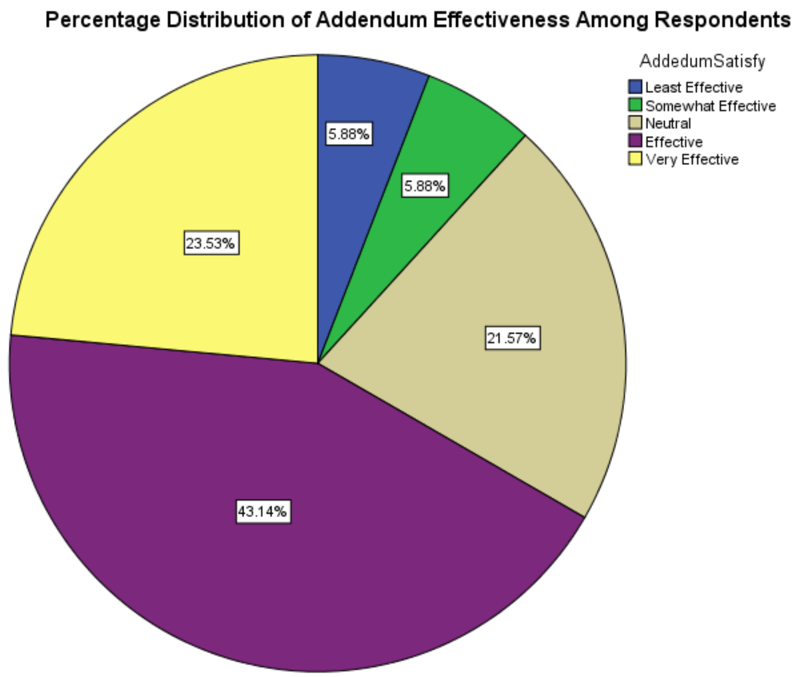

Figure 18. Percentage Distribution of Addendum Effectiveness among Respondents.

From Figure 18 it can be concluded that Addendum is an "Effective" way to use in order to satisfy Company A requirements with a percentage of 43.1%, followed by "Very Effective" with a percentage of 23.5%. Half of the percentage of the "Effective" option was for "Neutral" option with a percentage of 21.6%. "Least Effective" & "Somewhat Effective" had exactly the same percentage which is 5.9%.

Part 4

- *Description of Questions:*

Part 4 was about collecting engineer's opinion on creating new technical standards for Company A. The engineers were asked to identify the agreement level of this option using a five-point Likert Scale, where 1 represented "Least Effective" and 5 "Very Effective".

- *Results Obtained:*

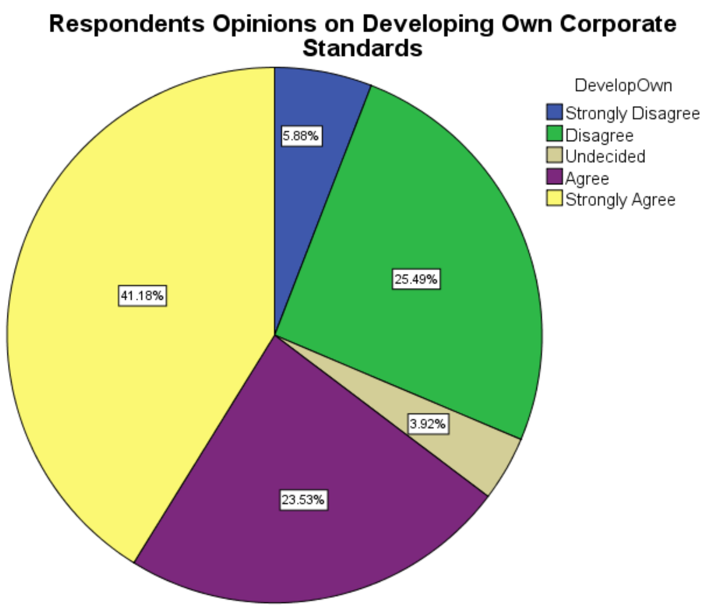

Figure 19. Respondents Opinion on Developing New Corporate Standards.

From Figure 19 it can be concluded that 64.71% (Strongly agree and Agree) of the engineers support the idea of developing new corporate standards and obtain a new set of standards that meet all the requirements of Company A. 31.37% (Strongly Disagree and Disagree) of the engineers did not support the idea of developing new Corporate standards and 3.92% chose "Undecided" option.

5.2. Analytical Part

In this part, data obtained from descriptive part above were further analyzed using Importance Satisfaction Matrices, Radar Chart and Pareto Chart.

5.2.1. Radar Charts

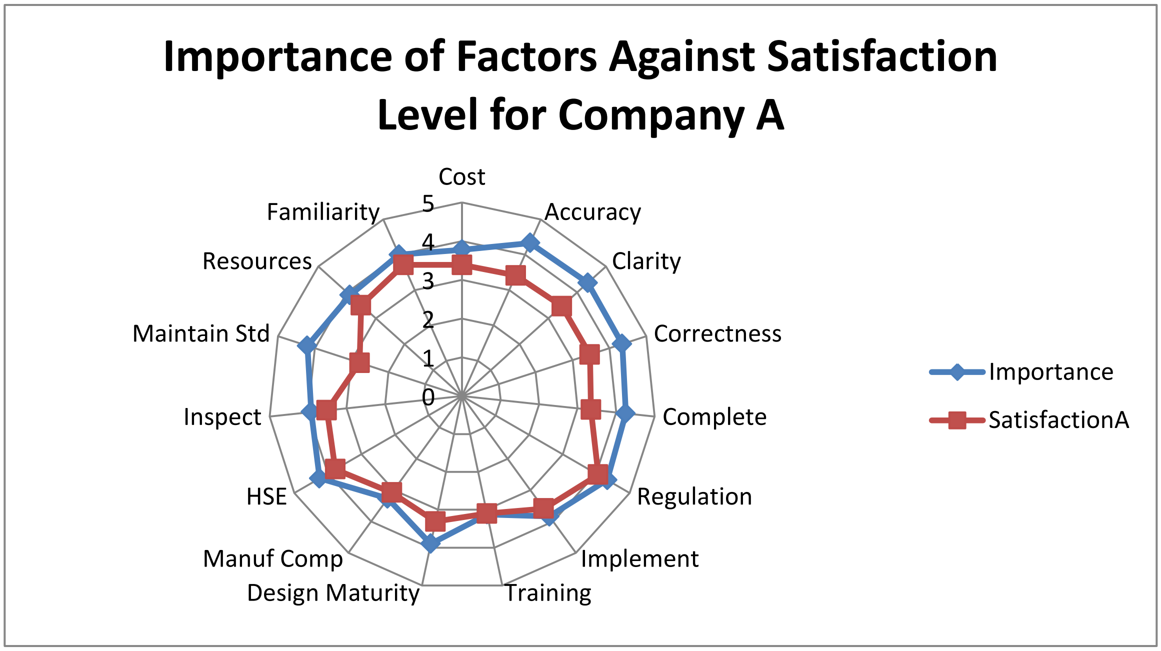

Figure 20. Radar Chart For Importance Against Satisfaction for Company A.

Figure 20 shows the importance level against satisfaction level for Company A standards. From this figure, it can be concluded that the satisfaction level of all 15 factors are below the importance level. Five factors had the highest different (between 0.88 to 1.42) between importance and satisfaction level and they are: Maintaining the Standard, Accuracy, Clarity, Completeness & Applicability and Correctness.

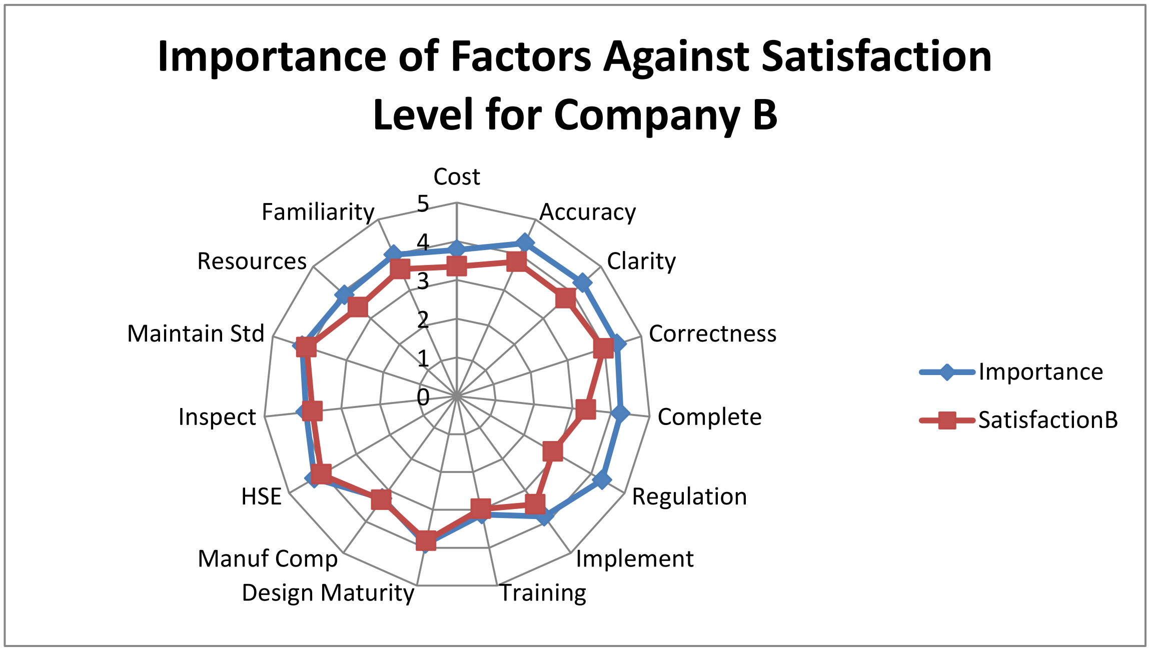

Figure 21. Radar Chart For Importance Against Satisfaction for Company B.

Figure 21 shows the importance level against satisfaction level for Company B Standards. From this figure, it can be concluded that the satisfaction level for 14 factors were below importance level while higher for one factor which is Manufacturing Complexity. Two factors had the highest difference between importance and satisfaction level and they are: Conforming to State Regulations and Completeness & Applicability.

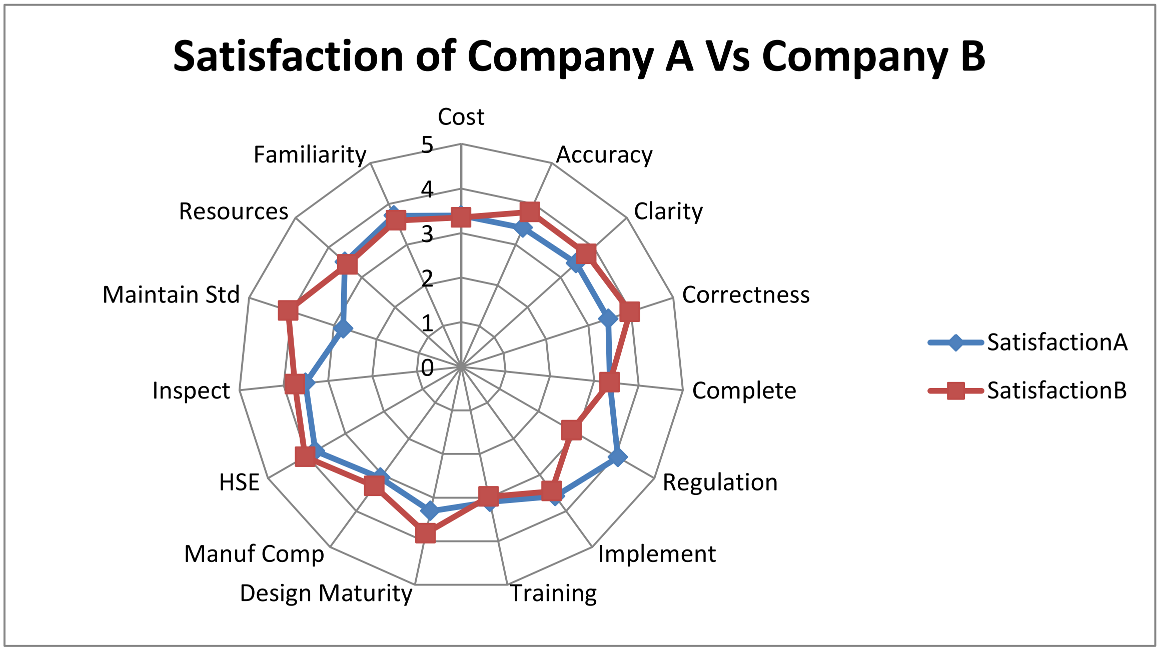

Figure 22. Radar Chart for Satisfaction Level of both Companies.

Figure 22 shows the satisfaction level of Company A Standards against satisfaction level of Company B. From this figure, it can be concluded that Company B Standards is better than Company A in the following factor: Accuracy, Clarity, Correctness, Design Maturity, Manufacturing Complexity, Health, Safety & Environment, Inspection & Certification and Maintaining the Standard. On the other hand, Company A Standards is better than Company B in the following factors: Conforming to State Regulations, Ease of Implementation, Availability of Resources to Implement and Familiarity with the Standard. For Impact on Project Cost, Training and

Completeness & Applicability factors, the satisfaction levels were almost the same.

5.2.2. Importance Satisfaction Matrices

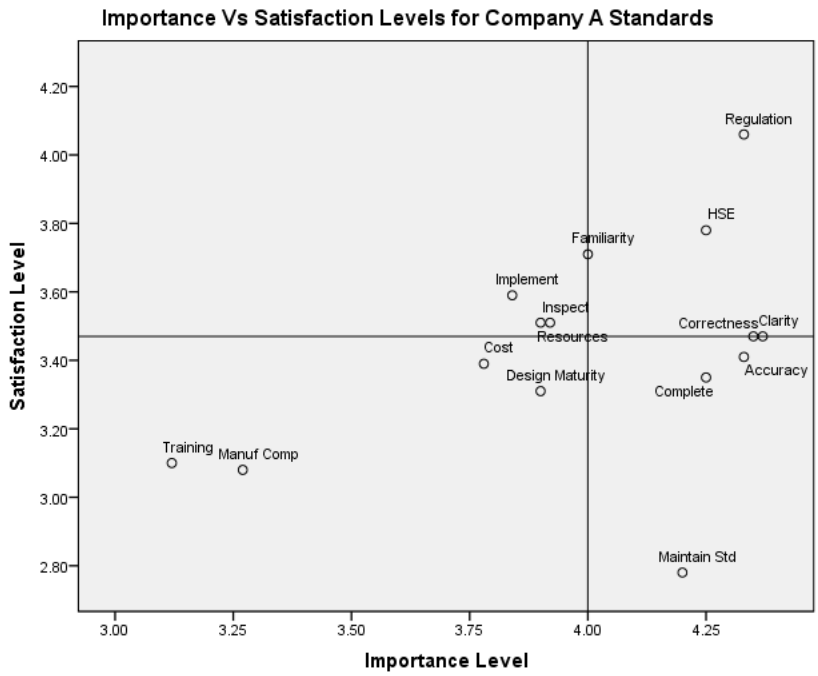

Figure 23. Importance Satisfaction Matrix for Company A.

Figure 23 shows the Importance-Satisfaction Matrix for Company A. The diagram is divided into four zones: Factors that have Low Satisfaction & Low Importance, Factors that have High Satisfaction but Low Importance, Factors that have High Importance but Low Satisfaction and Factors that have High Satisfaction & Importance. Out of these four zones, one zone is the most important which is the zone that covers factors with High Importance but Low Satisfaction. In this zone, three factors were found and they were: Accuracy, Completeness & Applicability and Maintaining Standards.

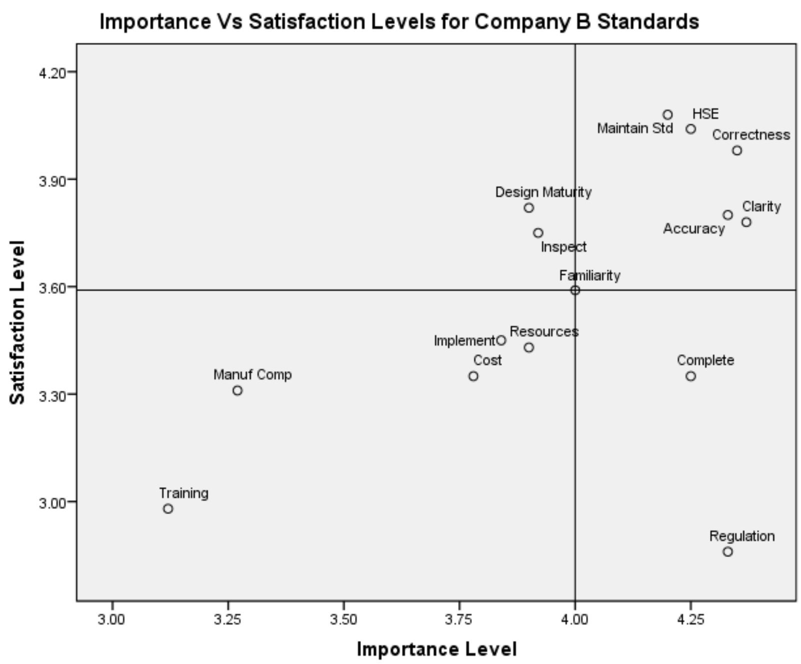

Figure 24. Importance Satisfaction Matrix for Company B.

Figure 24 shows the Importance-Satisfaction Matrix for Company B. For this figure, two factors are in the important zone with High Importance but Low Satisfaction levels. These two factors are: Completeness & Applicability and Conforming to State Regulations.

From these two Importance Satisfaction Matrices, it can be concluded that both standards have gaps. From Figure 22 it can be concluded that Company`s A standards have gaps in terms of Accuracy where on the other hand Company`s B standards are accurate. Also, there is a gap in maintaining Company`s A standards where on the other hand Company`s B standards are regularly maintained and the latest industry practices are always captured in the standards. Finally, both the standards have gaps in terms of being complete. This means that both the standards require to be modified to be complete and no company standards fits Company`s A use on a standalone basis.

5.2.3. Pareto Analysis

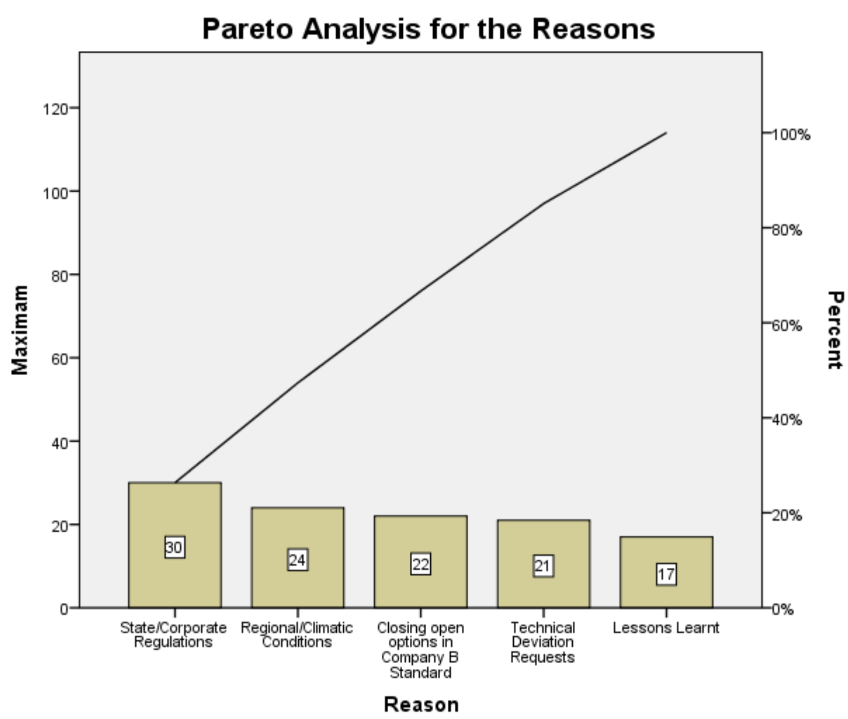

Figure 25. Pareto Chart for Reasons Necessitating Addendum Development.

From Figure 25 it can be concluded that most important factor that influences the development of addendum is State/Corporate Regulations which is a valid reason since Company B standards are designed for global use and for a National Company, there will be certain regulations that exists and Company A must adhere to and therefore developing addendum to match those requirements is necessary. Developing addendum because of Regional/Climatic Conditions, Closing Open Options in Company B standards and Technical Deviation Requests had all almost the same percentage which is between 20% to 24%. Developing Addendum because of the Lessons Learnt had the least percentage which is about 17%.

5.2.4. Analysis of Part 3 and 4 of the Questionnaire Based on Discipline Input

Table 21:

Feedback About Addendum Based on Discipline

Discipline	Part 3 (Question A)		Part 3 (Question C)				
	Necess-ary	Not Necessary	Least Effective	Somewhat Effective	Neutral	Effective	Very Effective
Mechanical	7	6	1	1	5	4	2
Electrical	6	0	0	0	1	2	3
Civil	11	2	2	1	2	7	1
Instrumentation	11	0	0	0	2	4	5
Process	5	1	0	1	1	4	0

Table 21 shows the necessity of developing Addendum & Influence level of factors based on discipline. From this table, it can be concluded that Electrical, Civil, Instrumentation and Process disciplines identified that addendum is an effective and necessary tool to be used when using Company B standards, while for Mechanical discipline, the necessity were divided between yes & no. This is because standards that are related to Mechanical are covered properly under Company B standards but not for all sections and that's why some engineers identified that addendum is a necessary & effective tool while other sections did not.

For Part 3 (Question C) it can also be concluded that all the four discipline agrees that addendum is an effective way to satisfy Company A requirements while for Mechanical it was divided across the five ratings with most of the responses as "Neutral" and least as "Least Effective" and "Somewhat Effective".

Table 22:

Feedback About Developing New Standards Based on Discipline

Discipline	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Mechanical	2	6	0	1	4
Electrical	1	0	1	1	3
Civil	0	0	0	3	10
Instrumentation	0	5	1	3	2
Process	0	2	0	3	2

Table 22 shows the agreement level on developing new corporate standards based on discipline input. From this table, it can be concluded that Engineers under Mechanical discipline were not supporting the idea of developing new standards while Electrical, Civil and Process discipline engineers fully support the idea of developing new standards. Instrumentation discipline engineers input were divided between Agree and Disagree with 5 inputs on each.

Chapter 6: Discussion

The purpose of this chapter is to discuss statistical analysis described in Chapter 5 and to conclude about engineer's feedback regarding gaps. Findings related to chosen options based on analysis have been discussed below:

1. Regarding Option 1 of choosing between Company A or Company B standards on standalone basis it was found that gaps exists in both sets. Company A has gaps in terms of Accuracy, Completeness & Applicability and Maintaining the Standards while Company B has gaps in Conforming to State Regulations and Completeness & Applicability. Also from the Importance Satisfaction Matrix Figure 23 & Figure 24, full satisfaction is achieved for Company B standards with regards to Maintenance of standards since they are updated on yearly basis while for Company A standards full satisfaction is achieved in terms of compliance to State Regulations.

It can be therefore concluded that neither Company A nor Company B standards can be used on a standalone basis since both standards have gaps and are incomplete with regards to Company A standardization requirements and both require additions to fulfill Company A requirements.

2. With relation to the two remaining options; which were Renewal of agreement for using Company B Standards (Option 2) and Development of new Corporate Standards (Option 3), a detailed analysis to identify the best option for the Company A to adopt is captured below. The analysis consisted of three parts: General Analysis, Business Analysis and Cost Analysis.

General Analysis

In this part, general analysis on the remaining two options was carried out. The analysis was about identifying advantages, disadvantages, requisites, success factors, scope, time and resources required for both the options. The results were summarized in Table 23 below.

Table 23:

General Analysis for Two Remaining Options

	Option 2	**Option 3**
Advantages	- System is already in place and in use. - Minimal effort to operate and maintain. - Cost analysis concludes this option to be cheaper of the two. - Technical support at request from Company B. - Company has interaction with manufacturers, suppliers & vendors and so all new technologies and updates will be available to Company A at minimum effort.	- Company B Standards are available as an easy starting base. - Company B Standards updates are available. - Technical support on Company B Standards is available. - Company B Standards license may be discontinued 3 years earlier.

Table 23 (Continued):

General Analysis for Two Remaining Options

	Option 2	Option 3
Disadvantages	- Dependence on Company B.	- Significant Company A effort will be required to develop and maintain the standards up to date.
Requisites	- Renew license with Company B for another term. - Enforce application of Company B Standards in company`s projects.	- Option implementation to be taken up on a project footing. - Setup permanent operational team for standards. - Setup regular monitoring of industry trends and revisions to international standards.
Success Factors	- Project rationalize the list of standards for application in contracts. - Discipline engineers become more familiar with Company B standards.	- Updates to consider: • Internal – RTS & TDR • External – statutory, international standards, industry trends • Preset revision date
Scope	- Initiate renewal discussions with Company B. - Arrange for fund allocation and budget approval. - Arrange with Legal for preparing Licensing Agreement for signature.	- Stage 1: Consultancy service for developing standards. - Stage 2: Organizational, business and procedural setup for operation, update and maintenance.

Table 23 (Continued):

General Analysis for Two Remaining Options

	Option 2	Option 3
Time	One year before agreement expires.	Preferably should start at least 3 years prior to expiry of agreement.
Resources	- Normal resources for contracting from: • Standards • Planning • Contracts • Legal	- Stage 1: Normal resources for contracting from: • Standards • Planning • Contracts - Stage 2: Dedicated team for operation, review, update and maintenance of standards

Business Analysis

In this part, two analyses were considered: Enterprise Ranking and Business Continuity Criticality Ranking.

a. Enterprise Risk Ranking for Options

Enterprise risk analysis aims to identify the risks associated with implementing the remaining two options on the company`s capital & earnings. Three kinds of risk were considered in this analysis as follows: Regulatory, Operational and Financial. Regulatory risk consists of risks related to compliance with laws & government regulations. Operational risks include risks that arise during execution of business functions to achieve business objectives (people, process, plant). Financial involves risk of inadequate financial appraisal that may result in inefficient allocation of resources. For each kind of risk, the level of negative impact on the enterprise in adopting the option was analyzed. Table 24 below summarizes the results of enterprise risk analysis. Three risk levels were used:

1. Acceptable: the risk is acceptable to the company.
2. Manageable: the risk has a bigger impact but can be managed.
3. Unacceptable: the risk is not acceptable to the company because it will results in severe damage to the company.

Table 24:

Enterprise Risk Analysis for Two Remaining Options

Option / Risk type	Option 2	Option 3
Regulatory	1	1
Operational	1	1
Financial	1	1

- Impact scale: 1 = low; 2-4 = medium; 5 = high *b. Business Continuity Criticality Ranking for Options*

Business continuity is an important aspect in any company since it ensures that the business will continue to operate when crisis, incident, or disaster happens to the company and will be able to operate back into its original state in a short time. Three kinds of resources were considered in analyzing business continuity and they were: Manpower, IT systems and Important documents. Table 25 summarizes the business continuity analysis results. Manpower is critical personnel who performs functions or operations that are critical to the company. IT Systems involves functions, outputs or outcomes which depend on the availability of this "telecommunication". Important documents are documents that will affects business continuity and will lead to losing reputation or lose financially if there are lost or damaged. For each resource type, the level of negative impact on the business from loss of the resource because of adopting the option was analyzed. Three levels were used:

1. Critical: if the business without this personnel, data or system will have serious negative impact on the business in the absence of alternative arrangements.

2. Necessary: Consequence of unavailability of the personnel, data or system for a short period of time may be managed/ contained but may become more severe over time. This process is necessary for survival but should nevertheless be resumed once critical processes are recovered.

3. Desirable: The unavailability of the personnel, data or system for a short or medium period of time will not severely impact the organization's business. Resumption of this business process may be deferred until after the major disruptive event or after all critical and necessary processes have been recovered.

Table 25:

Business Continuity Analysis for Two Remaining Options

Option / Resource type	Option 2	Option 3
Manpower	1	2
IT systems	3	2
Important documents	2	3

- Impact scale: 1 = not severe; 2 = managed; 3 = serious

The following table (Table 26) summarizes the obtained results from business analysis:

Table 26:

Business Analysis Summary for Two Remaining Options

	Option 2	Option 3
Enterprise risk	Acceptable	Acceptable
Business continuity criticality	Critical	Critical

From Business analysis, it can be concluded that both the options have the same impact in terms of enterprise risk and business continuity.

Cost Analysis

The last kind of analysis is the Cost analysis. In this part, two kinds of cost were considered: Development and Maintenance costs.

The following calculations were conducted based on the following assumptions:

- Number of years considered in the analysis: 10 years
- For calculating development cost for Option 2, cost of agreement after it expires were used based on 3% escalation.
- For calculating development cost for Option 2, two costs have been used: cost for specifications and cost for standard drawing.
- Total number of days required to develop one specification is 15 man-days while 10 man-days for standard drawing.
- Total number of days required to maintain one specification or standard drawing is 10 man-days.
- Total number of specifications that is required to be developed are based on Company`s B Specifications & Standard Drawings.
- Cost for developing one specification is QAR 4500 per man-day and for standard drawing it is QAR 3000 per man-day based on recent consultancy rates used by Company A.
- Cost for maintaining one specification or standard drawing it is QAR 3000 per man-day based on recent consultancy rates used by Company A.

- Standards team that consists of minimum 14 SMEs should be hired on Call-off basis for development and maintenance of Company A own set of standards.

Calculating the cost of the two options:

<u>1. Continue using company B standards:</u>

- Development Cost = 2,943,176.88 * 10 = QAR 29,431,768.8
- Maintenance Cost = QAR 0 (since the updates will be received on an annual basis)

<u>2. Develop new Standards:</u>

- Development Cost for Specifications = 331 * 15 * 4500 = QAR 22, 342,500
- Development Cost for Standard Drawings = 855 * 10 * 3000 = QAR 25,650,000
- Total Development Cost = 22, 342,500 + 25,650,000 = QAR 47,992,500
- Maintenance Cost = 1,186 * 10 * 3000 = QAR 35,580,000

The following table (Table 27) summarizes the costs obtained:

Table 27:

Cost Analysis Summary for Two Remaining Options

	Option 2	**Option 3**
Development Cost, QAR	29,431,768.8	47,992,500
Maintenance Cost, QAR	0.0	35,580,000
Total Cost, QAR	29,431,768.8	83, 572, 500

From the above cost analysis, it is clear that Option 2 which is renewing the license with Company B is the cheapest among the two remaining options.

The following Table (Table 28) summarizes the results obtained from these three analyses.

Table 28:

Detailed Analysis Summary

SI No.	Analysis	Option 2	Option 3
1	General Analysis	• More advantages • Less time • Less resources required	• Less advantages • More time • More resources required
2	Business Analysis - Business Continuity - Enterprise Risk	 Acceptable Critical	 Acceptable Critical
3	Cost Analysis	QAR 29,431,768.8	QAR 83, 572, 500

After conducting the above detailed analysis, my recommendation to Company A is to select Option 2 which is clearly in-line with results obtained from the above analysis carried out. The implementation success of this option is by establishing a suitable implementation guideline.

Chapter 7: Developing Implementation Guideline

In order to successfully implement the recommended option that was selected at the end of Chapter 6, the following process need to be followed:

1. Renewal of Agreement:

   Initiate the agreement renewal process one year prior to the expiry of current agreement.

2. Management Directives for Implementation:

   Ensure management of Company A issue directives for strict implementation of Company B standards and use them as default engineering standards.

3. Establishment of Implementation Guideline:

   Establish an implementation guideline would ensure that a proper strategy is followed for standardization and it should cover the shortcomings experienced during Phase III (discussed in Chapter 3: History of Engineering Standards in Company A). The implementation guideline consists of the following steps:

   i. Preparation of Master List of Engineering Standards:

   Preparation of discipline-wise master list by SMEs. The Master list should contain a complete set of standards that would fulfill Company A standardization requirements which means that it should include the following:

   a. List of engineering standards selected from Company B list which are applicable to Company A requirements.

   b. List of engineering standards applicable to Company A requirements but are not covered in Company B list of standards.

ii. Gap Analysis:

Gap analysis needs to be carried out to ascertain:

a. Completeness of each of the selected engineering standards from Company B needs to be checked against the following listed factors:

- Regional/climatic conditions: As Company B standards are developed for global applications, requirements specific to the region and climate may not be sufficiently covered by its standards.

- State/Corporate regulations: Company B standards do not cover completely the technical requirements of State/Corporate regulations.

- Any other factors related to TDR, lessons learnt, etc in Company`s A experience that need to be captured to supplement Company B standard.

b. Completeness of the set of selected standards from Company B: This exercise will be already covered during master list preparation and that is identification of list of applicable engineering standards that are not covered in Company B standards but applicable to Company A requirements.

iii. Recommendations to Fill Gaps Identified in Step ii (Gap Analysis)

With reference to point (a) of gap analysis (step ii above) which is related to completeness of the selected specific standard, it is recommended to fill the gap by developing addendum to the related selected standard.

With reference to point (b) of gap analysis (step ii above) which is related to completeness of set of selected standards from Company B, it is recommended to fill the gap by developing new corporate standards.

Thus the development of addendums or corporate standards along with the standards selected from Company B list completes Company A standardization requirements and can be used for designing future projects.

Table 29:

Implementation Guideline Summary

Activity	Time	Resource
1. Renewal of Agreement	One year before agreement expires	Contracts, Legal, Planning & Standards
2. Management Directives for Implementation	One Week	Standards & Technical Directorate Management
3. Establishment of Implementation Guideline		
3.1 Preparation of Master List of Engineering Standards	One month	Engineering Discipline & Standards
3.2 Gap Analysis	Three months	Engineering Discipline & Standards
3.3 Recommendations to Fill Gaps Identified		
3.3.1 Developing Addendum to Company B Standards	Three months (per Addendum)	Engineering Discipline & Standards
3.3.2 Developing New Corporate Standards	Six months (per standards	Engineering Discipline & Standards

Chapter 9: Conclusion, Limitations of the Study & Future Scope of Work

9.1 Conclusion

In conclusion, this paper was about identifying the right option that Company A should adopt after the agreement ends with Company B. Three options were studied: use Company A or Company B standards on standalone basis, renew its agreement with Company B, develop a new set of company standards and. Questionnaire were used to collect engineers opinion on both company`s standards and to identify acceptability of both companies standards. Different statistical tools were used to analyze the data that were obtained using SPSS & Excel software. After conducting statistical analysis, the first option was excluded and detailed analyses were carried for the two remaining options. According to detailed analyses that were conducted, the second option was identified as the best option for Company A where the company needs to renew its agreement with Company B and develop an implementation guideline for fulfilling their standards requirement.

In general, benchmarking & gap analysis approach are effective tools in establishing a standardization system. It can be used by companies to identify their gaps compared to international practices in order to improve the quality of their standards. Importance Satisfaction Matrix was used to identify those gaps in this research and it is found that this tool is very effective and useful. Furthermore, in standards adoption field, different tools should be combined together in order to identify the best option for the company.

9.2 Limitations of the Study

The limitations in this study were the following:

1. Questionnaire was distributed based on selective sampling and therefore the sample size has not been statistically justified. Also, the view of two people was taken to measure the impact scale against each selected risk type for Enterprise Risk analysis.
2. In this study, only two companies were involved in the analysis.
3. The identity of the companies was not revealed and so many details were not included in the analysis since some of the data from the company were used.
4. For conducting the cost analysis for the two options, some assumptions were made.

9.3 Future Scope of Work

This study that was conducted included engineers who are working in design engineering department only. Therefore, the study can be further extended to include people from other departments such as executing departments because their requirements in terms of importance and satisfaction might be different than results obtained in this analysis and then a comparison can be made between the two departments.

Furthermore, it is recommended for Company A to apply detailed analysis; general, business and cost for whole package that the company is receiving from Company B in order to get better and accurate results. In addition to that, one type of benchmarking approach were used in this study, and in the future more types can be used and included in order to compare between the two company`s standards that might results in obtaining different conclusion. The study included 51 responses only and in the future the study can be conducted again using a bigger sample size. Also, two companies only were used in the analysis, and it can be further extended by including more companies in the analysis.

Finally, it is recommended for Company A in the future to dedicate a team that is responsible for developing and maintaining its standards because they will develop the standards that best meets its requirements and regulations whether they are State or Corporate. Moreover, the team would know the best practices that suits Company A projects and they can use deviation and lessons learned that they gain after executing different projects.

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Appendixes

Appendix A: Questionnaire

Standards Development Activities in Company A

Description: As part of my research master program, I`m conducting a study to understand standards development activities in Company A. I`m trying to cover the following Standards in this study: Company A Standards, Company B Standards, and Company A Addendums to Company B Standards. Your feedback and time spent is really appreciated.

Contact Information:

- Name: Sara Mansoor
- Email: sm1001264@student.qu.edu.qa

Part 1: General Questions

1. What is your engineering discipline?

2. What is your qualification level?

- PhD Degree
- Master Degree
- Bachelor degree
- Diploma degree
- No engineering degree but lots of technical expertise

3. In which discipline?

- Mechanical Engineering
- Electrical Engineering
- Civil Engineering
- Instrumentation Engineering
- Process Engineering

4. Please specify the number of years of total work experience

- 0-5 years
- 5-10 years
- 10-15 years
- 15-30 years
- over 30 years

5. How many years have you been working with Company A?

- 0-5 years
- 5-10 years
- 10-15 years
- 15-20 years
- over 20 years

6. Please specify the extent of use of Company A Engineering Standards in the last 6 years in execution of projects assigned to you

- Never used
- Rarely used
- Moderately used
- Extensively used
- Always used

7. Please specify the extent of use of Company B Standards in the last 6 years in execution of projects assigned to you

- Never used
- Rarely used
- Moderately used
- Extensively used
- Always used

Part 2: In this part of the survey, kindly identify the importance and satisfaction ratings for the factors listed in the Table as per filling instructions below.

A. Importance rating: Please indicate the importance level of the listed factors which would influence your selection of standards.
B. Satisfaction rating: Please indicate the satisfaction level provided by Company A/ Company B standards with regards to the listed factors.
C. 1- Lowest level & 5-Highest level

Factors	Importance Rating						Satisfaction Rating										
							Company B						Company A				
	1	2	3	4	5		1	2	3	4	5		1	2	3	4	5
Impact on Project Cost																	
Accuracy																	
Clarity																	
Correctness																	
Completeness & Applicability																	
Conforming to State Regulations																	
Ease of Implementation																	
Require training																	
Design Maturity																	
Manufacturing Complexity																	
HSE																	
Inspection & Certification																	
Maintaining Standard																	
Availability of resources to implement																	
Familiarity with the Standard																	

Part 3: In this part of the survey, you are required to assess the effectiveness of Company A Addendum to Company B.

A. In your opinion, is the practice of developing addendums a necessary and effective tool?

- Yes
- No

B. Please identify the influence level of the listed factors in necessitating the development of addendums

Factors	1 (No influence)	2 (Rarely influenced)	3 (Sometimes Influenced	4 (Often influenced)	5 (Always influence)
Regional/Climatic Conditions					
State/Corporate Regulations					
Lessons Learnt					
Technical Deviation Requests					
Closing open options in Company B Standards					

C. Does the combination of Company B standards and Addendums effectively satisfy Company A engineering requirement

O	O	O	O	O
1 (Least effective)	2 (Somewhat effective)	3 (Neutral)	4 (Effective)	5 (Very effective)

Part 4: Please provide your opinion for creation of Company`s A own Technical Standards

O	O	O	O	O
1 (Strongly disagree)	2 (Disagree)	3 (Undecided)	4 (Agree)	5 (Strongly agree)

Part 5: Please provide your recommended course of action that Company A should follow after the agreement ends with Company B

- Update Company A standards as per current industry practices and use it as default Engineering Standards
- Renew Agreement with Company B
- Develop new Company A Corporate Technical Standards
- Rely on International Standards (ex: API, ISO, BSI, DIN, ASTM,..,etc)
- Adopt another International Oil Company Standards like (ExxonMobil, BP, Conoco Phillips, Total, etc.)
- Other (Please specify)

Appendix B: Descriptive Statistics for Part 1

Statistics

		Qualification	Discipline	Total Work Experience in Years	Working Experience in Company A	Extent of Use of Company A Standards	Exten of Use of Company B Standards
N	Valid	51	51	51	51	51	51
	Missing	0	0	0	0	0	0
Mean		2.53	2.75	4.24	2.55	3.90	3.67
Median		3.00	3.00	4.00	2.00	4.00	4.00
Mode		3	1	4	2	4	4
Std. Deviation		.578	1.398	.681	1.205	.944	.909
Variance		.334	1.954	.464	1.453	.890	.827
Range		2	4	3	4	3	3
Minimum		1	1	2	1	2	2
Maximum		3	5	5	5	5	5
Sum		129	140	216	130	199	187
Percentiles	25	2.00	1.00	4.00	2.00	3.00	3.00
	50	3.00	3.00	4.00	2.00	4.00	4.00
	75	3.00	4.00	5.00	3.00	5.00	4.00

Discipline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Mechanical	15	29.4	29.4	29.4
	Electrical	6	11.8	11.8	41.2
	Civil	13	25.5	25.5	66.7
	Instrumentation	11	21.6	21.6	88.2
	Process	6	11.8	11.8	100.0
	Total	51	100.0	100.0	

Working Experience in Company A

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-5 year	11	21.6	21.6	21.6
	5-10 year	16	31.4	31.4	52.9
	10-15 year	13	25.5	25.5	78.4
	15-20 year	7	13.7	13.7	92.2
	Over 20 years	4	7.8	7.8	100.0
	Total	51	100.0	100.0	

Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PhD	2	3.9	3.9	3.9
	Master	20	39.2	39.2	43.1
	Bachelor	29	56.9	56.9	100.0
	Total	51	100.0	100.0	

Total Work Experience in Years

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5-10 years	2	3.9	3.9	3.9
	10-15 years	1	2.0	2.0	5.9
	15-30 years	31	60.8	60.8	66.7
	Over 30 years	17	33.3	33.3	100.0
	Total	51	100.0	100.0	

Extent of Use of Company A Standards

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely Used	4	7.8	7.8	7.8
	Moderately Used	13	25.5	25.5	33.3
	Extensively Used	18	35.3	35.3	68.6
	Always Used	16	31.4	31.4	100.0
	Total	51	100.0	100.0	

Extent of Use of Company B Standards

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Rarely Used	7	13.7	13.7	13.7
	Moderately Used	11	21.6	21.6	35.3
	Extensively Used	25	49.0	49.0	84.3
	Always Used	8	15.7	15.7	100.0
	Total	51	100.0	100.0	

Appendix C: Kruskal-Wallis H Test

C1. Importance of Factors

Ranks

	Discipline	N	Mean Rank
CostImp	Mechanical	15	28.37
	Electrical	6	39.33
	Civil	13	17.54
	Instrumentation	11	24.23
	Process	6	28.33
	Total	51	
AccuracyImp	Mechanical	15	32.37
	Electrical	6	27.00
	Civil	13	26.12
	Instrumentation	11	17.36
	Process	6	24.67
	Total	51	
ClarityImp	Mechanical	15	31.37
	Electrical	6	26.00
	Civil	13	26.88
	Instrumentation	11	16.73
	Process	6	27.67
	Total	51	
CorrectnessImp	Mechanical	15	25.73
	Electrical	6	30.33
	Civil	13	30.08
	Instrumentation	11	18.05
	Process	6	28.08
	Total	51	
CompletnessImp	Mechanical	15	22.97
	Electrical	6	26.08
	Civil	13	32.04
	Instrumentation	11	24.36
	Process	6	23.42
	Total	51	
InspectionImp	Mechanical	15	34.73
	Electrical	6	36.67
	Civil	13	24.65
	Instrumentation	11	14.64
	Process	6	17.25
	Total	51	
RegulationsImp	Mechanical	15	26.50
	Electrical	6	31.58
	Civil	13	26.04
	Instrumentation	11	22.86
	Process	6	24.83
	Total	51	
ImplementationImp	Mechanical	15	26.63
	Electrical	6	30.58
	Civil	13	33.15
	Instrumentation	11	16.50
	Process	6	21.75
	Total	51	
TrainingImp	Mechanical	15	36.87
	Electrical	6	23.00
	Civil	13	21.31
	Instrumentation	11	20.55
	Process	6	22.00
	Total	51	
DesignMaturityImp	Mechanical	15	26.27
	Electrical	6	32.67
	Civil	13	27.81
	Instrumentation	11	21.09
	Process	6	23.75
	Total	51	
ManufacturingComplexImp	Mechanical	15	29.03
	Electrical	6	30.08
	Civil	13	27.42
	Instrumentation	11	22.00
	Process	6	18.58
	Total	51	
HSEImp	Mechanical	15	33.00
	Electrical	6	33.67
	Civil	13	20.69
	Instrumentation	11	18.45
	Process	6	26.17
	Total	51	
MaintainStdImp	Mechanical	15	32.17
	Electrical	6	27.67
	Civil	13	27.62
	Instrumentation	11	16.18
	Process	6	23.42
	Total	51	
ResourcesImp	Mechanical	15	31.90
	Electrical	6	29.58
	Civil	13	28.15
	Instrumentation	11	15.86
	Process	6	21.58
	Total	51	
FamiliarityImp	Mechanical	15	32.27
	Electrical	6	24.92
	Civil	13	27.54
	Instrumentation	11	17.23
	Process	6	24.17
	Total	51	

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of CostImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.029	Reject the null hypothesis.
2	The distribution of AccuracyImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.088	Retain the null hypothesis.
3	The distribution of ClarityImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.090	Retain the null hypothesis.
4	The distribution of CorrectnessImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.203	Retain the null hypothesis.
5	The distribution of CompletnessImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.449	Retain the null hypothesis.
6	The distribution of RegulationsImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.750	Retain the null hypothesis.
7	The distribution of ImplementationImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.043	Reject the null hypothesis.
8	The distribution of TrainingImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
9	The distribution of DesignMaturityImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.533	Retain the null hypothesis.
10	The distribution of ManufacturingComplexImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.425	Retain the null hypothesis.
11	The distribution of HSEImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.019	Reject the null hypothesis.
12	The distribution of InspectionImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
13	The distribution of MaintainStdImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.060	Retain the null hypothesis.
14	The distribution of ResourcesImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.050	Reject the null hypothesis.
15	The distribution of FamiliarityImp is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.104	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

C2. Satisfaction Level of Factors in Company A

Ranks

	Discipline	N	Mean Rank
SatCostA	Mechanical	15	25.50
	Electrical	6	26.50
	Civil	13	26.62
	Instrumentation	11	20.77
	Process	6	35.00
	Total	51	
SatAccuracyA	Mechanical	15	23.37
	Electrical	6	24.08
	Civil	13	29.50
	Instrumentation	11	23.73
	Process	6	31.08
	Total	51	
SatClarityA	Mechanical	15	27.27
	Electrical	6	27.83
	Civil	13	28.62
	Instrumentation	11	20.86
	Process	6	24.75
	Total	51	
SatCorrectnessA	Mechanical	15	22.87
	Electrical	6	26.00
	Civil	13	31.42
	Instrumentation	11	23.82
	Process	6	26.08
	Total	51	
SatCompletnessA	Mechanical	15	21.30
	Electrical	6	30.50
	Civil	13	32.92
	Instrumentation	11	20.95
	Process	6	27.50
	Total	51	
SatRegulationsA	Mechanical	15	25.10
	Electrical	6	31.50
	Civil	13	27.77
	Instrumentation	11	21.95
	Process	6	26.33
	Total	51	
SatImplementationA	Mechanical	15	23.40
	Electrical	6	33.00
	Civil	13	31.35
	Instrumentation	11	19.32
	Process	6	26.17
	Total	51	
SatTrainingA	Mechanical	15	28.30
	Electrical	6	32.67
	Civil	13	24.96
	Instrumentation	11	19.36
	Process	6	28.00
	Total	51	
SatDesignMaturityA	Mechanical	15	19.90
	Electrical	6	31.83
	Civil	13	31.77
	Instrumentation	11	20.95
	Process	6	32.17
	Total	51	
SatManufacturingComplexA	Mechanical	15	27.80
	Electrical	6	33.75
	Civil	13	23.04
	Instrumentation	11	21.45
	Process	6	28.50
	Total	51	
SatHSEA	Mechanical	15	24.60
	Electrical	6	30.17
	Civil	13	29.31
	Instrumentation	11	23.09
	Process	6	23.50
	Total	51	
SatInspectionA	Mechanical	15	27.43
	Electrical	6	38.08
	Civil	13	24.65
	Instrumentation	11	19.91
	Process	6	24.42
	Total	51	
SatMaintainA	Mechanical	15	17.73
	Electrical	6	26.67
	Civil	13	29.58
	Instrumentation	11	29.95
	Process	6	31.00
	Total	51	
SatResourcesA	Mechanical	15	26.87
	Electrical	6	25.33
	Civil	13	29.00
	Instrumentation	11	20.82
	Process	6	27.50
	Total	51	
SatFamiliarityA	Mechanical	15	23.70
	Electrical	6	32.42
	Civil	13	31.50
	Instrumentation	11	20.55
	Process	6	23.42
	Total	51	

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of SatCostA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.361	Retain the null hypothesis.
2	The distribution of SatAccuracyA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.649	Retain the null hypothesis.
3	The distribution of SatClarityA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.703	Retain the null hypothesis.
4	The distribution of SatCorrectnessA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.566	Retain the null hypothesis.
5	The distribution of SatCompletnessA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.146	Retain the null hypothesis.
6	The distribution of SatRegulationsA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.710	Retain the null hypothesis.
7	The distribution of SatImplementationA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.174	Retain the null hypothesis.
8	The distribution of SatTrainingA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.301	Retain the null hypothesis.
9	The distribution of SatDesignMaturityA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.066	Retain the null hypothesis.
10	The distribution of SatManufacturingComplexA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.338	Retain the null hypothesis.
11	The distribution of SatHSEA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.732	Retain the null hypothesis.
12	The distribution of SatInspectionA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.142	Retain the null hypothesis.
13	The distribution of SatMaintainA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.117	Retain the null hypothesis.
14	The distribution of SatResourcesA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.700	Retain the null hypothesis.
15	The distribution of SatFamiliarityA is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.232	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

C3. Satisfaction Level of Factors in Company B

Ranks

	Discipline	N	Mean Rank
SatCostB	Mechanical	15	28.63
	Electrical	6	39.42
	Civil	13	18.92
	Instrumentation	11	22.50
	Process	6	27.75
	Total	51	
SatAccuracyB	Mechanical	15	24.17
	Electrical	6	27.50
	Civil	13	22.12
	Instrumentation	11	27.05
	Process	6	35.58
	Total	51	
SatClarityB	Mechanical	15	29.40
	Electrical	6	31.17
	Civil	13	18.12
	Instrumentation	11	25.91
	Process	6	29.58
	Total	51	
SatCorrectnessB	Mechanical	15	29.93
	Electrical	6	21.17
	Civil	13	21.50
	Instrumentation	11	27.86
	Process	6	27.33
	Total	51	
SatCompletenessB	Mechanical	15	32.30
	Electrical	6	33.33
	Civil	13	15.50
	Instrumentation	11	23.36
	Process	6	30.50
	Total	51	
SatRegulationsB	Mechanical	15	27.93
	Electrical	6	33.67
	Civil	13	16.42
	Instrumentation	11	30.23
	Process	6	26.50
	Total	51	
SatImplementationB	Mechanical	15	34.70
	Electrical	6	24.75
	Civil	13	19.12
	Instrumentation	11	20.59
	Process	6	30.33
	Total	51	
SatTrainingB	Mechanical	15	32.13
	Electrical	6	27.17
	Civil	13	19.23
	Instrumentation	11	24.05
	Process	6	27.75
	Total	51	
SatDesignMaturityB	Mechanical	15	29.03
	Electrical	6	28.00
	Civil	13	20.35
	Instrumentation	11	25.45
	Process	6	29.67
	Total	51	
SatManufacturingComplexB	Mechanical	15	24.53
	Electrical	6	38.08
	Civil	13	22.35
	Instrumentation	11	24.73
	Process	6	27.83
	Total	51	
SatHSEB	Mechanical	15	29.57
	Electrical	6	29.67
	Civil	13	18.38
	Instrumentation	11	26.86
	Process	6	28.33
	Total	51	
SatInspectionB	Mechanical	15	24.73
	Electrical	6	37.00
	Civil	13	19.00
	Instrumentation	11	32.27
	Process	6	21.83
	Total	51	
SatMaintainB	Mechanical	15	29.70
	Electrical	6	27.67
	Civil	13	20.85
	Instrumentation	11	25.82
	Process	6	26.58
	Total	51	
SatResourcesB	Mechanical	15	28.20
	Electrical	6	33.67
	Civil	13	20.96
	Instrumentation	11	22.36
	Process	6	30.42
	Total	51	
SatFamiliarityB	Mechanical	15	25.13
	Electrical	6	31.67
	Civil	13	19.50
	Instrumentation	11	26.45
	Process	6	35.75
	Total	51	

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of SatCostB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.038	Reject the null hypothesis.
2	The distribution of SatAccuracyB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.373	Retain the null hypothesis.
3	The distribution of SatClarityB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.195	Retain the null hypothesis.
4	The distribution of SatCorrectnessB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.443	Retain the null hypothesis.
5	The distribution of SatCompletenessB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.011	Reject the null hypothesis.
6	The distribution of SatRegulationsB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.056	Retain the null hypothesis.
7	The distribution of SatImplementationB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.024	Reject the null hypothesis.
8	The distribution of SatTrainingB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.175	Retain the null hypothesis.
9	The distribution of SatDesignMaturityB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.492	Retain the null hypothesis.
10	The distribution of SatManufacturingComplexB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.185	Retain the null hypothesis.
11	The distribution of SatHSEB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.237	Retain the null hypothesis.
12	The distribution of SatInspectionB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.046	Reject the null hypothesis.
13	The distribution of SatMaintainB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.568	Retain the null hypothesis.
14	The distribution of SatResourcesB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.268	Retain the null hypothesis.
15	The distribution of SatFamiliarityB is the same across categories of Discipline.	Independent-Samples Kruskal-Wallis Test	.143	Retain the null hypothesis.

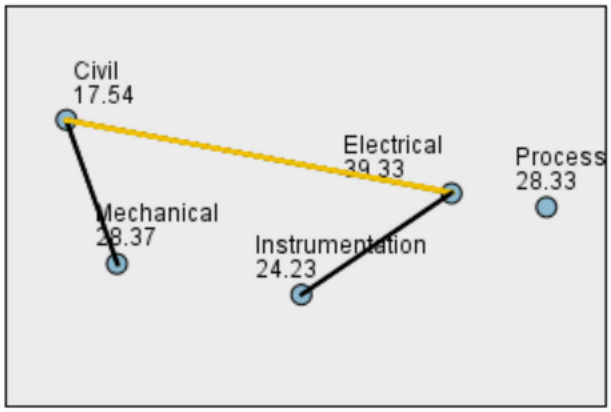
Asymptotic significances are displayed. The significance level is .05.

Appendix D: Pairwise Comparisons

D1. Importance of Factors

Table D1.1 Impact on Project Cost Factor

Pairwise Comparisons of Discipline

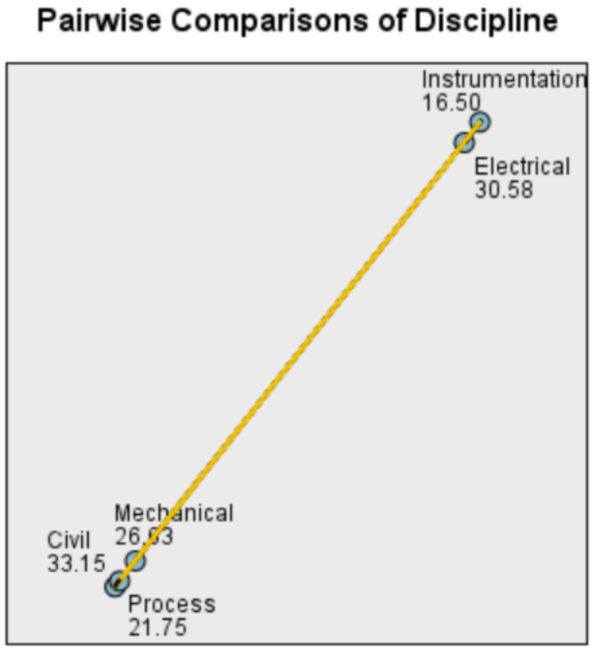


Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Civil-Instrumentation	-6.689	5.771	-1.159	.246	1.000
Civil-Process	-10.795	6.952	-1.553	.120	1.000
Civil-Mechanical	10.828	5.338	2.029	.042	.425
Civil-Electrical	21.795	6.952	3.135	.002	.017
Instrumentation-Process	-4.106	7.149	-.574	.566	1.000
Instrumentation-Mechanical	4.139	5.592	.740	.459	1.000
Instrumentation-Electrical	15.106	7.149	2.113	.035	.346
Process-Mechanical	.033	6.804	.005	.996	1.000
Process-Electrical	11.000	8.133	1.353	.176	1.000
Mechanical-Electrical	-10.967	6.804	-1.612	.107	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D1.2 Ease of Implementation Factor

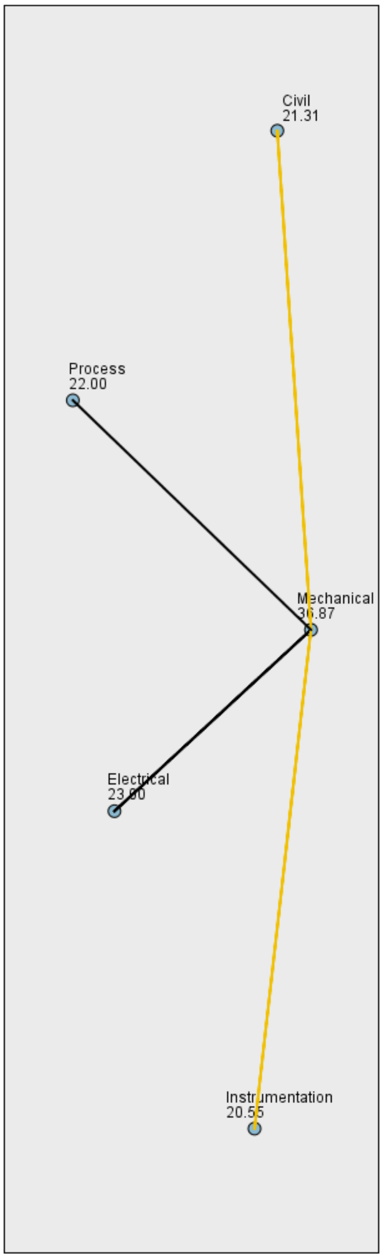


Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Instrumentation-Process	-5.250	7.049	-.745	.456	1.000
Instrumentation-Mechanical	10.133	5.513	1.838	.066	.661
Instrumentation-Electrical	14.083	7.049	1.998	.046	.457
Instrumentation-Civil	16.654	5.690	2.927	.003	.034
Process-Mechanical	4.883	6.709	.728	.467	1.000
Process-Electrical	8.833	8.019	1.102	.271	1.000
Process-Civil	11.404	6.855	1.664	.096	.962
Mechanical-Electrical	-3.950	6.709	-.589	.556	1.000
Mechanical-Civil	-6.521	5.263	-1.239	.215	1.000
Electrical-Civil	-2.571	6.855	-.375	.708	1.000

Table D1.3 Training Factor

Pairwise Comparisons of Discipline



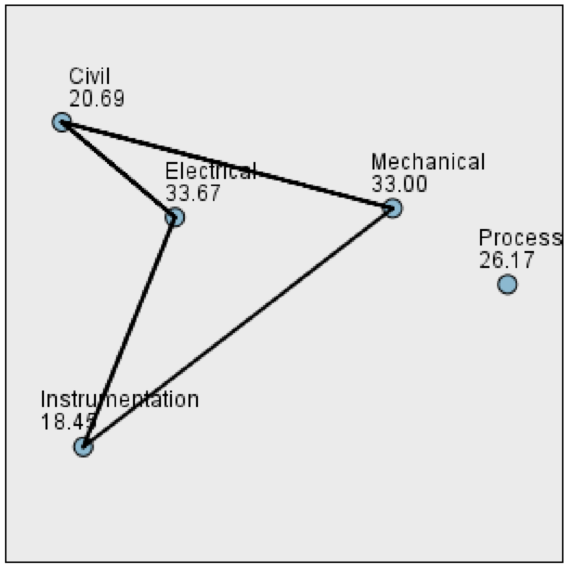
Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Instrumentation-Civil	.762	5.533	.138	.890	1.000
Instrumentation-Process	-1.455	6.854	-.212	.832	1.000
Instrumentation-Electrical	2.455	6.854	.358	.720	1.000
Instrumentation-Mechanical	16.321	5.361	3.044	.002	.023
Civil-Process	-.692	6.666	-.104	.917	1.000
Civil-Electrical	1.692	6.666	.254	.800	1.000
Civil-Mechanical	15.559	5.118	3.040	.002	.024
Process-Electrical	1.000	7.797	.128	.898	1.000
Process-Mechanical	14.867	6.524	2.279	.023	.227
Electrical-Mechanical	13.867	6.524	2.126	.034	.335

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D1.4 HSE Factor

Pairwise Comparisons of Discipline



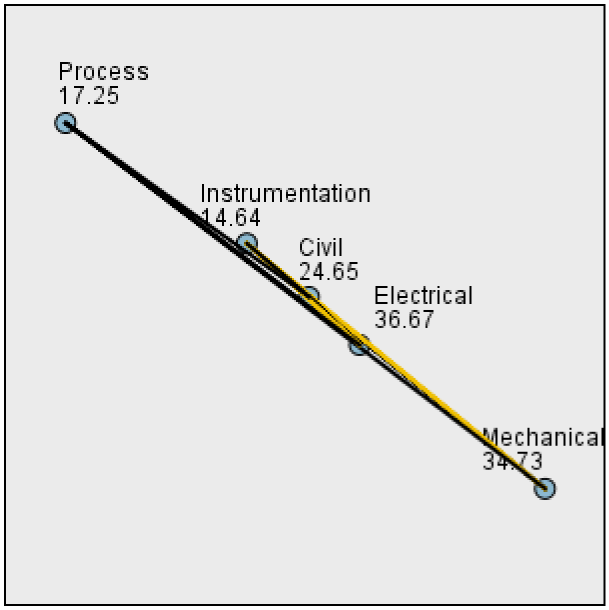
Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Instrumentation-Civil	2.238	5.456	.410	.682	1.000
Instrumentation-Process	-7.712	6.759	-1.141	.254	1.000
Instrumentation-Mechanical	14.545	5.286	2.751	.006	.059
Instrumentation-Electrical	15.212	6.759	2.251	.024	.244
Civil-Process	-5.474	6.573	-.833	.405	1.000
Civil-Mechanical	12.308	5.046	2.439	.015	.147
Civil-Electrical	12.974	6.573	1.974	.048	.484
Process-Mechanical	6.833	6.433	1.062	.288	1.000
Process-Electrical	7.500	7.689	.975	.329	1.000
Mechanical-Electrical	-.667	6.433	-.104	.917	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D1.5 Inspection & Certification Factor

Pairwise Comparisons of Discipline



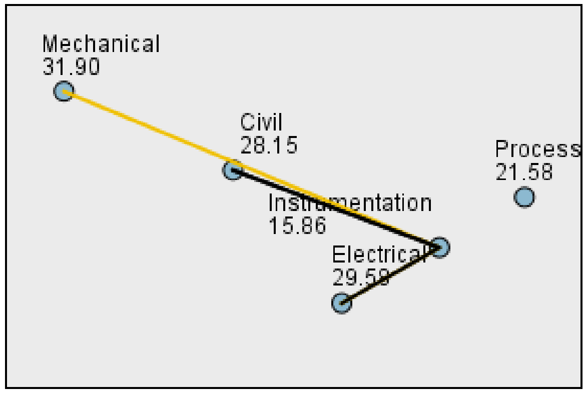
Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Instrumentation-Process	-2.614	7.162	-.365	.715	1.000
Instrumentation-Civil	10.017	5.781	1.733	.083	.831
Instrumentation-Mechanical	20.097	5.602	3.588	.000	.003
Instrumentation-Electrical	22.030	7.162	3.076	.002	.021
Process-Civil	7.404	6.965	1.063	.288	1.000
Process-Mechanical	17.483	6.817	2.565	.010	.103
Process-Electrical	19.417	8.148	2.383	.017	.172
Civil-Mechanical	10.079	5.348	1.885	.059	.594
Civil-Electrical	12.013	6.965	1.725	.085	.846
Mechanical-Electrical	-1.933	6.817	-.284	.777	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D1.6 Availability of Resources Factor

Pairwise Comparisons of Discipline



Each node shows the sample average rank of Discipline.

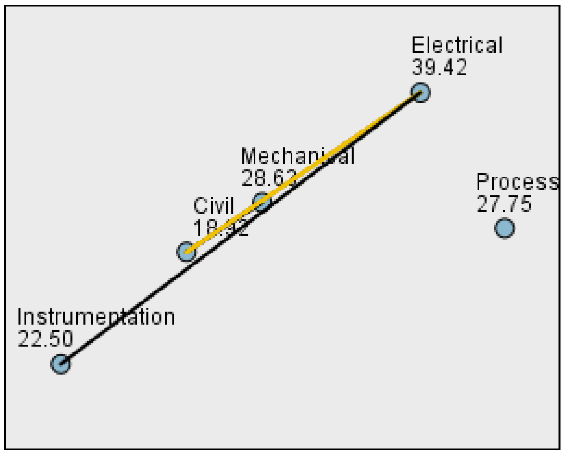
Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Instrumentation-Process	-5.720	7.191	-.795	.426	1.000
Instrumentation-Civil	12.290	5.805	2.117	.034	.342
Instrumentation-Electrical	13.720	7.191	1.908	.056	.564
Instrumentation-Mechanical	16.036	5.625	2.851	.004	.044
Process-Civil	6.571	6.993	.940	.347	1.000
Process-Electrical	8.000	8.181	.978	.328	1.000
Process-Mechanical	10.317	6.844	1.507	.132	1.000
Civil-Electrical	1.429	6.993	.204	.838	1.000
Civil-Mechanical	3.746	5.369	.698	.485	1.000
Electrical-Mechanical	2.317	6.844	.338	.735	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

D2. Satisfaction Level of Factors for Company B

Table D2.1 Impact on Project Cost Factor

Pairwise Comparisons of Discipline



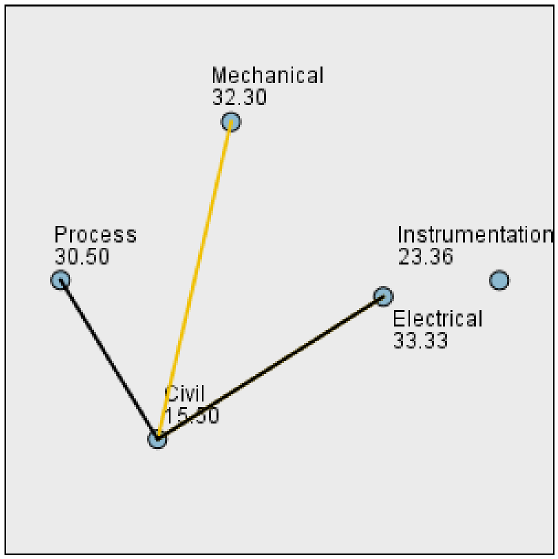
Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Civil-Instrumentation	-3.577	5.729	-.624	.532	1.000
Civil-Process	-8.827	6.902	-1.279	.201	1.000
Civil-Mechanical	9.710	5.299	1.832	.067	.669
Civil-Electrical	20.494	6.902	2.969	.003	.030
Instrumentation-Process	-5.250	7.097	-.740	.459	1.000
Instrumentation-Mechanical	6.133	5.551	1.105	.269	1.000
Instrumentation-Electrical	16.917	7.097	2.383	.017	.171
Process-Mechanical	.883	6.755	.131	.896	1.000
Process-Electrical	11.667	8.074	1.445	.148	1.000
Mechanical-Electrical	-10.783	6.755	-1.596	.110	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D2.2 Completeness & Applicability Factor

Pairwise Comparisons of Discipline



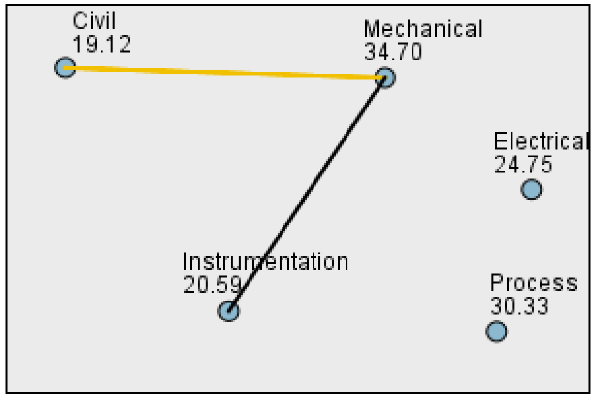
Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Civil-Instrumentation	-7.864	5.735	-1.371	.170	1.000
Civil-Process	-15.000	6.910	-2.171	.030	.299
Civil-Mechanical	16.800	5.305	3.167	.002	.015
Civil-Electrical	17.833	6.910	2.581	.010	.099
Instrumentation-Process	-7.136	7.105	-1.004	.315	1.000
Instrumentation-Mechanical	8.936	5.557	1.608	.108	1.000
Instrumentation-Electrical	9.970	7.105	1.403	.161	1.000
Process-Mechanical	1.800	6.763	.266	.790	1.000
Process-Electrical	2.833	8.083	.351	.726	1.000
Mechanical-Electrical	-1.033	6.763	-.153	.879	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D2.3 Ease of Implementation Factor

Pairwise Comparisons of Discipline



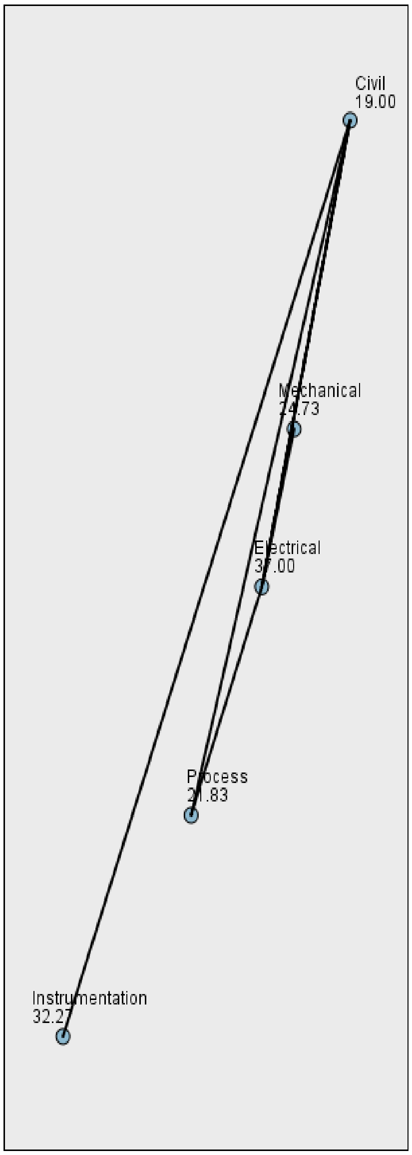
Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Civil-Instrumentation	-1.476	5.715	-.258	.796	1.000
Civil-Electrical	5.635	6.885	.818	.413	1.000
Civil-Process	-11.218	6.885	-1.629	.103	1.000
Civil-Mechanical	15.585	5.286	2.948	.003	.032
Instrumentation-Electrical	4.159	7.079	.587	.557	1.000
Instrumentation-Process	-9.742	7.079	-1.376	.169	1.000
Instrumentation-Mechanical	14.109	5.537	2.548	.011	.108
Electrical-Process	-5.583	8.054	-.693	.488	1.000
Electrical-Mechanical	9.950	6.738	1.477	.140	1.000
Process-Mechanical	4.367	6.738	.648	.517	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Table D2.4 Inspection & Certification Factor

Pairwise Comparisons of Discipline



Each node shows the sample average rank of Discipline.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Civil-Process	-2.833	6.947	-.408	.683	1.000
Civil-Mechanical	5.733	5.334	1.075	.282	1.000
Civil-Instrumentation	-13.273	5.766	-2.302	.021	.213
Civil-Electrical	18.000	6.947	2.591	.010	.096
Process-Mechanical	2.900	6.799	.427	.670	1.000
Process-Instrumentation	10.439	7.144	1.461	.144	1.000
Process-Electrical	15.167	8.126	1.866	.062	.620
Mechanical-Instrumentation	-7.539	5.587	-1.349	.177	1.000
Mechanical-Electrical	-12.267	6.799	-1.804	.071	.712
Instrumentation-Electrical	4.727	7.144	.662	.508	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.
Significance values have been adjusted by the Bonferroni correction for multiple tests.

Appendix E: Descriptive Statistics for Part 3

E1. Part 3A

Statistics

AddendumNecessary

N	Valid	51
	Missing	0
Mode		1
Range		1
Minimum		1
Maximum		2

AddendumNecessary

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	42	82.4	82.4	82.4
	No	9	17.6	17.6	100.0
	Total	51	100.0	100.0	

E2. Part 3B

LessonsLearntDevelop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.0	2.0	2.0
	2	5	9.8	9.8	11.8
	3	17	33.3	33.3	45.1
	4	16	31.4	31.4	76.5
	5	12	23.5	23.5	100.0
	Total	51	100.0	100.0	

StateDevelop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.0	2.0	2.0
	2	2	3.9	3.9	5.9
	3	6	11.8	11.8	17.6
	4	12	23.5	23.5	41.2
	5	30	58.8	58.8	100.0
	Total	51	100.0	100.0	

OpenOptionsDevelop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	2.0	2.0	2.0
	2	6	11.8	11.8	13.7
	3	22	43.1	43.1	56.9
	4	11	21.6	21.6	78.4
	5	11	21.6	21.6	100.0
	Total	51	100.0	100.0	

TDRDevelop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	7.8	7.8	7.8
	2	6	11.8	11.8	19.6
	3	21	41.2	41.2	60.8
	4	15	29.4	29.4	90.2
	5	5	9.8	9.8	100.0
	Total	51	100.0	100.0	

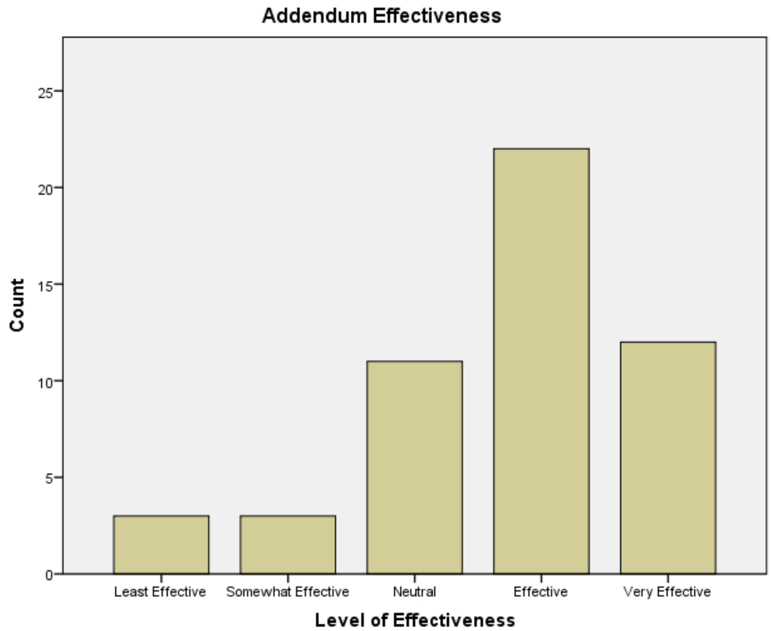
RegionalDevelop

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	5.9	5.9	5.9
	3	9	17.6	17.6	23.5
	4	15	29.4	29.4	52.9
	5	24	47.1	47.1	100.0
	Total	51	100.0	100.0	

E3. Part 3C

AddedumSatisfy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Least Effective	3	5.9	5.9	5.9
	Somewhat Effective	3	5.9	5.9	11.8
	Neutral	11	21.6	21.6	33.3
	Effective	22	43.1	43.1	76.5
	Very Effective	12	23.5	23.5	100.0
	Total	51	100.0	100.0	



Appendix F: Descriptive Statistics of Part 4

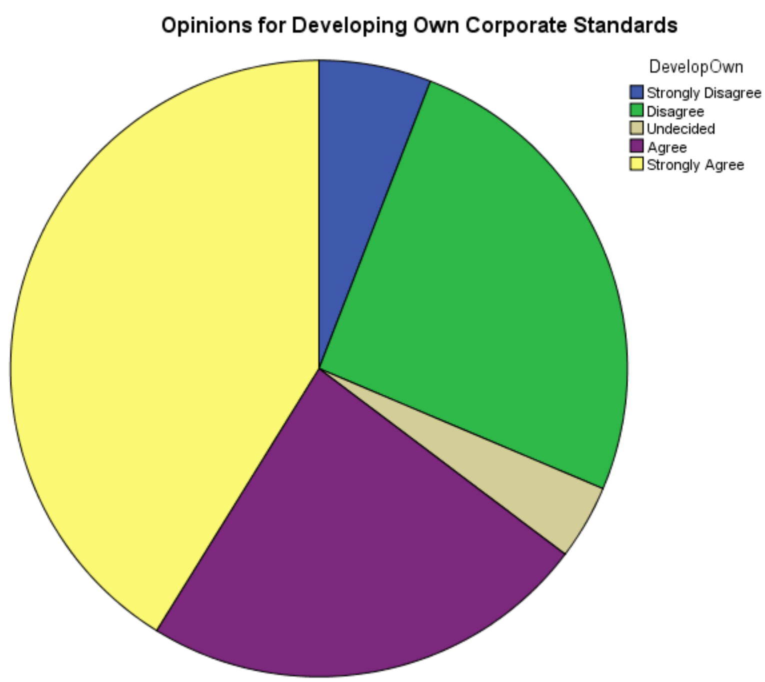
Statistics

DevelopOwn

N	Valid	51
	Missing	0
Mean		3.69
Median		4.00
Mode		5
Std. Deviation		1.393
Variance		1.940
Range		4
Minimum		1
Maximum		5
Sum		188
Percentiles	25	2.00
	50	4.00
	75	5.00

DevelopOwn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	5.9	5.9	5.9
	Disagree	13	25.5	25.5	31.4
	Undecided	2	3.9	3.9	35.3
	Agree	12	23.5	23.5	58.8
	Strongly Agree	21	41.2	41.2	100.0
	Total	51	100.0	100.0	



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