

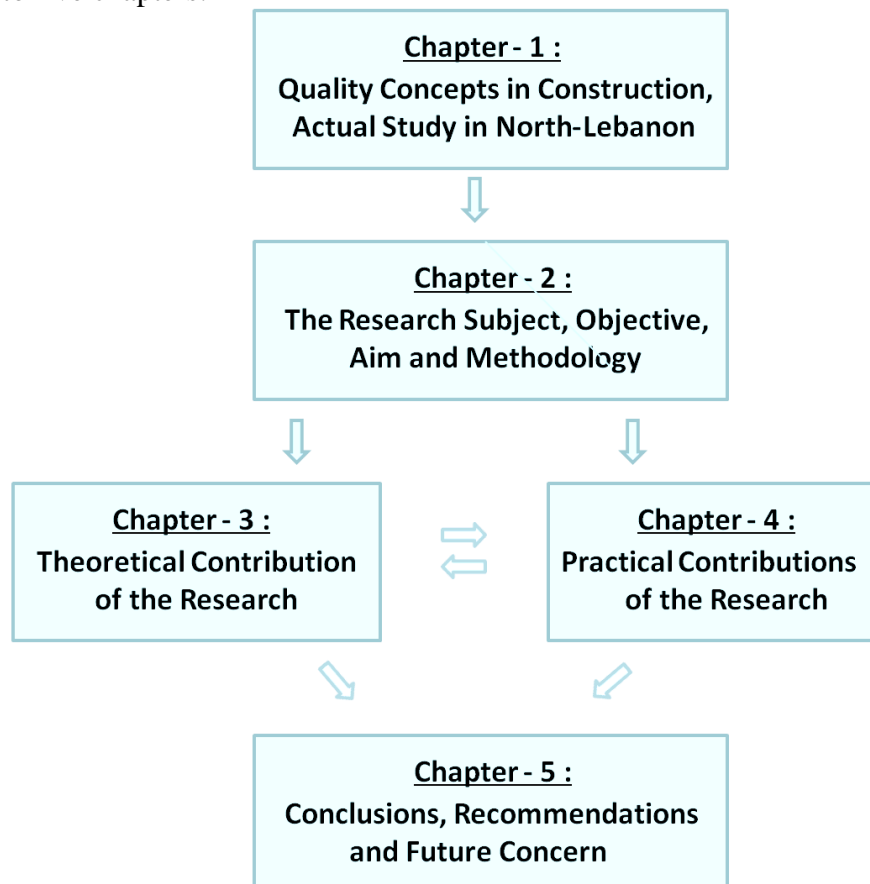
Background:

Many are the papers and researches published in regard with the Total Quality Management (TQM) application and implementation either in the manufacturing or in the services industries. However, with a focus to the construction sector, papers, researches and publications remain very few. With regard to the later sector, and aiming to compete locally and globally, companies and organizations with different cultures and attitudes tend to follow the international improvements where quality is a major concern for customer satisfaction.

Upon such concern, this research thesis targets the implementation of the Total Quality Management approach in the North-Lebanese construction industry, by identifying and developing a suitable TQM model, which may be adopted by construction companies (in Lebanon) aiming to solve or eliminate problems related to the ever-changing customer needs and the generation of profits for the stakeholders. A “Win-Win” situation to apply, aiming enormous We believe that if TQM has been implemented in some countries and are yielding enormous quality improvements and higher organizational performance.

Thesis Structure:

For a well comprehensive thesis structure, the author proposed the following layout with thesis divided into five chapters:



CHAPTER 1

QUALITY CONCEPTS IN CONSTRUCTION ACTUAL STUDY OF THE LEBANESE COUNTRY (NORTH)

1.1 – General Introduction:

Despite this notable contribution to the economy of developing countries where Lebanon is one of, the construction industry performance still remains low. Many projects encounter considerable time and cost overruns, fail to realize their intended benefit or even totally terminated and abandoned before or after their completion [80]. The approach of the TQM in the construction industry is to involve all construction key players, at all level of the organizations, taking right decisions at the early stages of the project; this will ensure big revenues in terms of time saving, money saving and added project value. TQM may generate a mutual “Win-Win” scenario for all the construction industry parties [139].

Accordingly a need to undertake a research in application of Total Quality Management in the Lebanese construction sectors come out where quality and performance improvement within the construction sector is considered a priority action for the researcher.

1.2 – The Quality Evolution:

Quality has been defined as the “degree to which a set of inherent characteristics fulfils requirements” [85]. As for quality in the construction context, the proposal is to divide it into two elements, one for product and the other for service. Customers will only then be satisfied when both have met their expectations. With regard to modern concept of quality four phases apply:

- Inspection;
- Quality control;
- Quality assurance;
- Total Quality Management.

1.3- Quality in Construction:

Quality has a three-fold meaning in construction, it means:

- “Getting the job done on time”;
- “Ensuring basic characteristics of the final project fall within the required specifications”;
- “Getting the job done within budget”.

The quality of a construction project is related to the quality management in the different stages of the project lifecycle from design till operation and maintenance.

1.3.1- Quality Defined in Construction:

As per the literature review, the concept of quality can be categorized into three main groups:

- *Corporate Quality*: refers to the image that customers have of an organization [181].
- *Product Quality* (at Project Level): refers to the customer's satisfaction related to the output of the process (construction) [47].
- *Service Quality* (at Project Level): refers to the customer's satisfaction related to the service itself.

1.3.2 –Concepts for Effective Quality Management Systems in Construction:

The establishment and implementation of total quality management systems in the specific construction-type organization is based on concepts that include:

- a system within which, the company can meet or even exceeds customers' expectations;
- a system that have clear definitions of responsibilities;
- a system that ensures efficient business processes;
- a system well advised by the ISO 9001:2015 standards and principles;
- a system considering people's understanding commitment;
- a system subject to continuous (on-going) improvements.

1.3.3 – Effectiveness of implementing a QMS in Construction:

Effectiveness, as per ISO 9001:2015 and the 8 QM principles, should mean [9,94]:

- The full meeting of a company's own specified quality requirements;
- Meeting the prescribed quality objectives.

1.3.4 – ISO 9001:2015 Standard and the 20 Elements for Construction Procedures:

Nowadays, the ISO 9001:2015 is considered an essential standard to be applied to the construction industry even though the particularity of the projects in terms of uniqueness and involvement of many participants and suppliers.

- ISO 9001:2015 summarizes twenty elements related to quality in construction;
- ISO 9001:2015 five clauses and the 8 QM principles; inter-dependence is also presented;

1.3.5 – Benefits and Barriers of Applying ISO 9001:2015 in construction:

Many are the benefits in applying ISO 9001:2015 or TQM approach in the competitive environment of the construction industry at different areas of improvements as: construction project, project management, quality, organization performance, and management system.

Where in regard to the construction industry, the QMS ISO9001:2015 development and implementation requires specific written documentation and needs long integration period, yielding to higher operating costs; Another barrier is the company's management, not interested in research and development and blocked to any criticism;

Never to forget the uniqueness of the construction projects with their long time of completion, the different human relationships which yield to difficulty in establishing and implementing QMS [136].

1.3.6 –Quality and Customer Satisfaction in Construction:

The customer satisfaction approach defines quality as “the extent to which a product or service meets and/or exceeds a customer's expectations”. This approach is related to the customer's viewpoint, showing what is important to the customer rather than establishing standards not too accurate. In the construction industry, *product quality* refers to achieving quality in the materials, equipment and technology that go into the building of a structure, whereas *process quality* refers to achieving quality in the way the project is organized and managed in the three phases of design, construction, and operation and maintenance.

1.4- Total Quality Management in Construction:

According to different literatures, Total Quality Management is well thought-out as a high level of quality strategy than that offered by QMS [174]. TQM targets all level personnel of the organization to be involved in high quality outcomes with continuous improvement attaining client satisfaction.

1.4.1 –TQM Approach in Construction:

The construction sector in developing countries is regarded as a poor quality emphasis industry [178]; indifferently from the project size, inputs are repetitive in the buildings. The redo actions, the repairs and maintenance all use the same repeated processes. Thus, the focus should exceed the construction (execution) itself and goes forward to the design and planning phases;

1.4.2 – Need for and Aim of TQM in Construction:

The construction industry itself is now targeting better quality products and services after a long period of criticism of its poor performance, low productivity, waste and health and safety problems. Recently, construction companies have started (especially in developing counties) to adopt TQM as a proposal in cracking quality problems and meeting customers' requirements and satisfaction.

Most construction companies in North-Lebanon are small to medium sized companies where TQM implementation could be easier than large ones. Also, it might be the first step towards

improving the practices of the parties who are involved in the construction companies and in turn improve the construction companies' situation.

The implementation of TQM in Lebanon is still weak. However, the consciousness of the TQM concept is at its lower level and the TQM critical success factors are not well-recognized and practiced.

1.4.3- Elements of TQM in Construction:

Accepted elements of TQM and construction industry-specific factors that affect quality of the process of a building project are:

- Management Commitment and Leadership:
- Training:
- Teamwork:
- Statistical Methods:
- Cost of quality:
- Supplier Involvement:
- Customer Service:
- Construction Industry Specific Factors.

1.4.4- Implementation of TQM in Construction:

The implementation of the TQM concepts, practices and techniques in the construction industry may end with big revenues and benefits, saving millions of dollars while controlling processes and prevent defects before they happen.

TQM affects client satisfaction, employee satisfaction, quality of construction implementation, and project performance; the benefits of its implementation can be summarized in the well controlled processes, reduction of the cycle time, less damage in goods, better site material delivery, higher performance levels and better perceived viewpoint of the customers.

To the construction industry, the implementation of TQM ends with achieving competitiveness, increasing market-share, improving profitability and improving quality services.

1.4.5- Problems with the implementation of TQM in construction:

When dealing with construction, some of the industry problems are themselves barriers for TQM implementation: Construction firms reactive rather than proactive, long-term nature of the industry, traditional or conventional practices within it, and resistance to organization's culture change. Never to forget the engagement of all construction key-players in the process, that makes TQM so hard to implement within the construction sector [70].

1.5- Critical Success Factors (CSF), of TQM in Construction:

The good determination of the critical success factors ends up with valuable achievements in construction projects;

Management work in construction profit from CSFs in:

- Helping management in strategic decision making [160];
- Selecting the appropriate working team, determining his development needs and forecasting the level of performance [41];
- Analyzing the reasons of project success or failure [112];
- Enabling effective allocation of project limited resources [127].

Upon a deep literature review and with reference to other quality management frameworks, the researcher suggests the following CSFs for the local construction industry:

1.5.1- Leadership / Top Management Commitment:

“Top management commitment or leadership” is a vital factor in the implementation of TQM in construction [97]. As for the Lebanese local construction market, it shows different cultural workforces based on different employees originalities; the management has to deal with such constraints, by understanding their personalities and necessities.

1.5.2- Quality Culture:

Nowadays, since the challenge for construction companies are getting bigger, changing the business strategy towards quality is becoming a must [76]. This necessitates a change in culture for all members of the organization at a first step: a change that targets “what people think”, “what they do” and “what materials they use and produce” [35].

1.5.3- Strategic Quality Management:

In order to provide better quality products targeting increased market-share and good reputation, organizations should have “strategic quality planning”, ending with the “implementation of TQM”. Strategic quality management is a vital issue to let employee be oriented towards the targeted objectives [134].

1.5.4- Process Management / Planning:

Based on three quality statements: “the vision statement”, “the mission statement” and the “quality policy”. Under process management, we distinguish:

- Quality process system
- Customer relation management
- Coordination and structure

1.5.5- Employee Empowerment:

Employee empowerment provides better quality in the executed job and more participation in the business process [72]. Benefits of empowerment are in two sections, benefits for individual and benefits for the organization [67,128], improving employee inputs and overall quality.

As for the construction sector, empowerment should not be limited to within organization but to go further to reach the project supply chain [21,125].

1.5.6- Employee Training and Education:

Employee training is the basic practices that an organization provides to improve specific skills in their employees to boost the organizational performance, quality, customer satisfaction and reduce time and costs” [17]. It should target all members at all levels of the organization, to minimize resistance to change and enable smooth implementation of the TQM concepts and its improvements [83,145].

1.5.7- Customer Satisfaction:

Is considered a primary key for competitiveness and market-share increase when customer needs and expectations are well understood and reached. For construction companies, there is inability to measure customer requirements and expectation where the project is unique and has a long time span [16], and customer delight is only detected in late phases of the project after spending lot of money [32,55,107].

The principle factors leading to customer satisfaction in construction are [36,98]:

- The effective site cooperation of the contractor;
- The supervisors and workers technical performance;
- The continuous measurement of the customer satisfaction and its feedback;
- The ability to respond to customer requests as fast as possible;
- Achieving the proposed plan ;
- The ability to work again with the same customer.

1.5.8- Continuous Improvement:

Regarding both process and products, it involves all employees within the organization [152]. If adequately applied, TQM will improve the company’s overall performance. Key elements are:

- Diagnose the malfunctioning system and search for the root causes;
- Benchmark to implement new improved systems;
- Team-work;
- Gradual change;
- Regularly evaluation of the operating system;

1.5.9- Impact on Environment:

Nowadays, sustainable concern is getting more and more importance, where Green or LEED certified project are becoming popular; and the environment is considered a fourth dimension to be added to time, cost and quality. Construction projects have big impact on environment with ecological, natural and environmental effects [183].

The researcher considers “Environmental Sustainability” as part of TQM but not a critical success factor of it.

1.5.10 –Communication:

As much as the communication process improves, as better it is easier to establish a good platform for TQM application and improvement within the processes of the construction industry.

1.5.11- Resource Management:

Resource management is considered one of the vital parameters to adequately implement the TQM concepts [6,36]. It includes:

- Human resources (HR);
- Information resources(IR);
- Financial resources(FR);
- Material resources(MR);
- Technological resources(TR);

1.6 - The Lebanese Country and the Construction industry:

The Lebanese construction industry shares many problems related to the poor level of performance of this industry; and according to the important role such industry plays in the economy of the country, it becomes a must improving its quality and performance.

Noting that, the particularity and characteristics of the Lebanese construction industry with its local rules and criteria, make the implementation of quality concepts and improvements much more difficult than expected.

1.6.1- Overview of the Lebanese Country:

Lebanon is one of the Middle Eastern countries, limited by Syria from both North and East sides, Palestine from the south, and the Mediterranean sea all along its West side. Lebanon extends over an area of 10,452 sq km. It is divided into 5 regional administrative areas (Mouhafazat): Lebanon has a shortage in financial and natural resources with high unemployment rate, poverty and high public debt.



Figure 1.11- Lebanon in the world [atlas].



Figure 1.12- Lebanon's administrative areas [atlas].

1.6.2- The construction Process:

During its life span, the construction project passes throughout different process stages [5] including the following phases:

- *Briefing phase*, data collection of customer requirements, and blueprint elaboration.
- *Design phase*, construction documentation, drawings, specification, and bill of quantities.
- *Bidding phase*, selection of the adequate contractor to carry out the work.
- *Construction phase*, building the facility conforming to drawings and specifications.
- *Commissioning phase*, taking over the facility by the user [15,47].

1.6.3- key Participants and their Roles in the Construction Process:

The construction process has different parties involved in it:

- A- The Owner / Employer** is the person or company that will own the finished facility.
- B- The client** can be considered as the motor of the process
- C- Professionals** are architects, quantity surveyors, civil, mechanical and electrical engineers, responsible for the developmental work.
- D- The contractor** carries out the construction works of the structure.
- E- Supplier** is in charge of providing the materials to carry out the construction work.
- F- Quantity Surveyor** is an advisor for the construction project cost via the preparation of tenders, contract and budget estimate.

1.6.4- Structures of the Local Constructions Firms:

Projects in the construction sector, necessitate the participation of different organizations coming together to implement and execute these projects. The adopted procurement systems define these interactions; they include:

- *The Traditional Procurement System:* is based on considering the design and construction as two separate (independent) responsibilities.
- *The Design and Build System (DB):* Via a merging approach that considers the contractor responsible of both “the design” and “the execution”; where the contractor is assigned the total responsibility of the design and construction phases with non-adversarial and less confrontational environment, in solving problems.
- *Management Contracting System (MC):* Rooting back to the idea of building with shorter time: overlapping both the design and construction processes and reducing the pre-contract period. A managing contractor links between owner, sub-contractors and the design team.
- *Project Management (PM):* is the overall planning, control and co-ordination of a project from inception to completion aimed at meeting client’s requirements and ensuring completion on time, within cost and to required quality standards.
- *Partnering:* is the arrangement that involves two or more organizations working together to improve the performance, agreeing mutual objectives, and committing themselves to continuous improvement, measuring progress and sharing the gains” [129].
- *The Build-Operate Transfer Approach (BOT):* whereby a client, awards to a group of investors a concession for development, operation, management and commercial exploitation of a particular project. BOT system has recently been introduced in Lebanon especially by the government for building and infrastructure projects.

1.6.5- Specific Characteristics of the Construction Industry in North-Lebanon:

Generally, the characteristics of the construction industry are linked to four types of uncertainty: Natural, Task, Organizational, Contractual. The combination of these characteristics with the poor workmanship, unclear drawings and specifications, lack of coordination, lack of build-ability, lack of contractor’s involvement in design and planning activities, are typically the major cases of the construction problems in the North-Lebanese applications; Never to forget the main issue with the private “solo” design and execution bureaus, where the concept of team work and hierarchical strategies are completely missing.

1.6.6- Economical and Financial Assets of TQM Implementation in North Lebanese Construction firms:

Similarly to any other developing country, the impact of TQM in the construction sector of the local North-Lebanese market can show big revenues summarized under the following sub-titles:

- Achieving competitiveness;
- Increasing market share;
- Improving profitability;
- Improving quality services;

CHAPTER 2

RESEARCH STRUCTURE, OBJECTIVE, AIM AND METHODOLOGY

2.1 – Research Concept:

With regard to the market globalization and the difficult economic status of the local construction market, specifically in North Lebanon region, construction products and services are in deep need for better qualifications and ratings to attract end-users. The “Good Quality” criteria or “Up to Standard” level, are becoming much more familiar at all levels of the key participants of the construction sector; but each at his own understanding and interest.

However, when overlooking the actual “local construction industry market” with its organizations, it clearly appears that there is an absence of well structured management systems for the assessment of quality of both “products” and “services” provided. Total Quality Management could be a competitive advantage in today’s business environment. TQM helps creating a culture of trust, participation and teamwork towards continuous improvement.

2.2 –Problem Identification and Research Motivation:

In this research, the problem is well determined to be the quality implementation in construction industries; the following questions are to be considered in the research perspective:

- “What is the impact of TQM on overall performance”?
- “What are the critical success factors for implementing TQM”?
- “What kind of TQM model should be developed to guide local Lebanese construction industries in implementing TQM”?

The researcher being a part of the local construction sector of North-Lebanon, considers appropriate to study the “TQM implementation level” in the local market, showing its importance for all key participants in the construction sector; the proposed model for implementation is considered so simple for application.

2.3 – Originality and Interests of the Study:

Nowadays, Quality appears to be an important consideration for construction organizations; but it is still considered as extra cost, where short term revenues are mostly well estimated than the long term ones. The direct interest of the study is to *move behind the Quality terminology* to a further step that shows how *to implement the quality mentality at all level of a construction organization*, where each construction project has its own characteristics and involving many contractors and subcontractors within the construction project timeframe.

2.4– Aim and Objectives of the research:

The aim of this study is to determine “the Critical Success Factors necessary for the implementation of total quality management” at different phases of the construction project “planning, design and construction”; the assessment of these factors can be used as base model to implement TQM in the construction sector in North-Lebanon. TQM implementation in the construction industry in Lebanon, specifically North, will improve quality practices and encourage continuous improvement and hence, higher organizational performance.

To accomplish this aim, a number of objectives are set:

- To investigate current practices of quality management in the Construction Industry;
- To identify any present problems with these practices;
- To identify critical success factors for TQM implementation;
- To assess these critical success factors and study the degree of consistency;
- To derive the relative weights of factors necessary for the TQM implementation;
- To develop a framework to help in implementing TQM during the different phases of construction project in North-Lebanon.

2.5– Contributions the Study:

- This study-work is almost the first and lonely one concerned with “the implementation of the TQM in construction industry in Lebanon (North)”.
- This research targets a new TQM management system and approach to be implemented within the North-Lebanese construction sector.
- This research makes contribution to the construction industry in North-Lebanon by identifying and offering solutions to the barriers confronting the construction companies in the implementation of TQM.

- The results of this research will help the constructions companies' directors in Lebanon to understand how to invest in and implement the concept of TQM more effectively, for better development and performance improvement of their tasks and processes.
- The outputs of this research may be employed as a tool that encourages the implementation of TQM in other industries in Lebanon.

2.6- Limitation of the Study:

The limitations of the research can summarized as follow:

- Only the construction industry in Lebanon-North is employed as a case study.
- The research focuses on the construction companies only, other types not discussed.
- The literature review within this study is based on work done in other countries, either developed ones or neighbor ones, since the topic is relatively new in developing countries and specifically in Lebanon.
- The data collected and interviews are limited to years of 2015 and 2016 only.

CHAPTER 3

THEORETICAL CONTRIBUTION OF THE RESEARCH

3.1 - Methodology and Research Design:

Research Methodology, for this particular research, it identifies the data to elaborate a net understanding of the TQM and its implementation within the Lebanese construction sector.

Research Design, for this research it determines the philosophy, approach, aim, objective, logic and outcome of the research, by selecting the procedures, plans, questions to be valid, accurate, effective and objective [2,105].

3.2- Chosen Approach of the Research:

For this particular research, the selected research approach is “a social, non- experimental, empirical and mixed quantitative-qualitative science” where the objective is to generate knowledge about total quality management within the construction industries of North-Lebanon.

3.3- The Quantitative and Qualitative Approaches:

3.3.1- Quantitative Data Collection: via postal survey, telephone-interview, web survey (email), panel survey, self-administered questionnaire survey, interviewer-administrated survey and mixed methods (hybrid) surveys.

3.3.2 - Qualitative Data Collection: There exist two main methods for collecting qualitative data, stated as direct and indirect approaches where the in-depth interviews, out of the direct approach is the most effective in providing deep discussions.

3.4- Secondary Data, Primary Data and Collection Methods:

There are two ways for data collection: secondary data collection and primary data collection.

3.4.1 - Secondary Data and its Collection: Is the available data in other resources or articles, textbooks, journals already published or unpublished that help in finding solutions for the problems in concern. The “secondary data” can be either “internal data” or “external data”.

3.4.2- Primary Data and its Collection: The primary data can be identified, as “*data originated by the researcher specifically to address the research problems*”. Such data consists of original material not interpreted by anyone else than the researcher. It is an up-to-date data with high credibility and accuracy.

3.5- Data Collection Methods Validity and Reliability:

For the purpose of this research internal consistency method is used because it is the most widely used reliable estimate in empirical research [165].

3.5.1- The Validity of Data Collection Methods

- **Criterion related validity:** Criterion-related is validity test (Spearman test) which measures the correlation coefficient between each paragraph in one field and the whole field.
- **Structure validity of the questionnaire:** Structure validity tests the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire.

As for case studies, “external validity deals with the problem of knowing whether a study’s findings are generalizable beyond the immediate case study” [116,182].

3.5.2- The Reliability of Data Collection Methods

Defined as the degree by which the method will yield consistent findings and how far similar observations would be made [108]. Its goal is to minimize the errors within a study.

3.6- Tools and Resources of the Research:

In order to collect the necessary data in an adequate form, different tools and resources are used:

- Documents and statistics related to the research objectives;
- Literatures and researches related to the research questions;
- Interviews with employees of construction companies in North-Lebanon;
- Questionnaire to collect data and information necessary for research study;
- Statistical analysis, and get results;
- Internet search.

3.7 - Flow Chart Methodology:

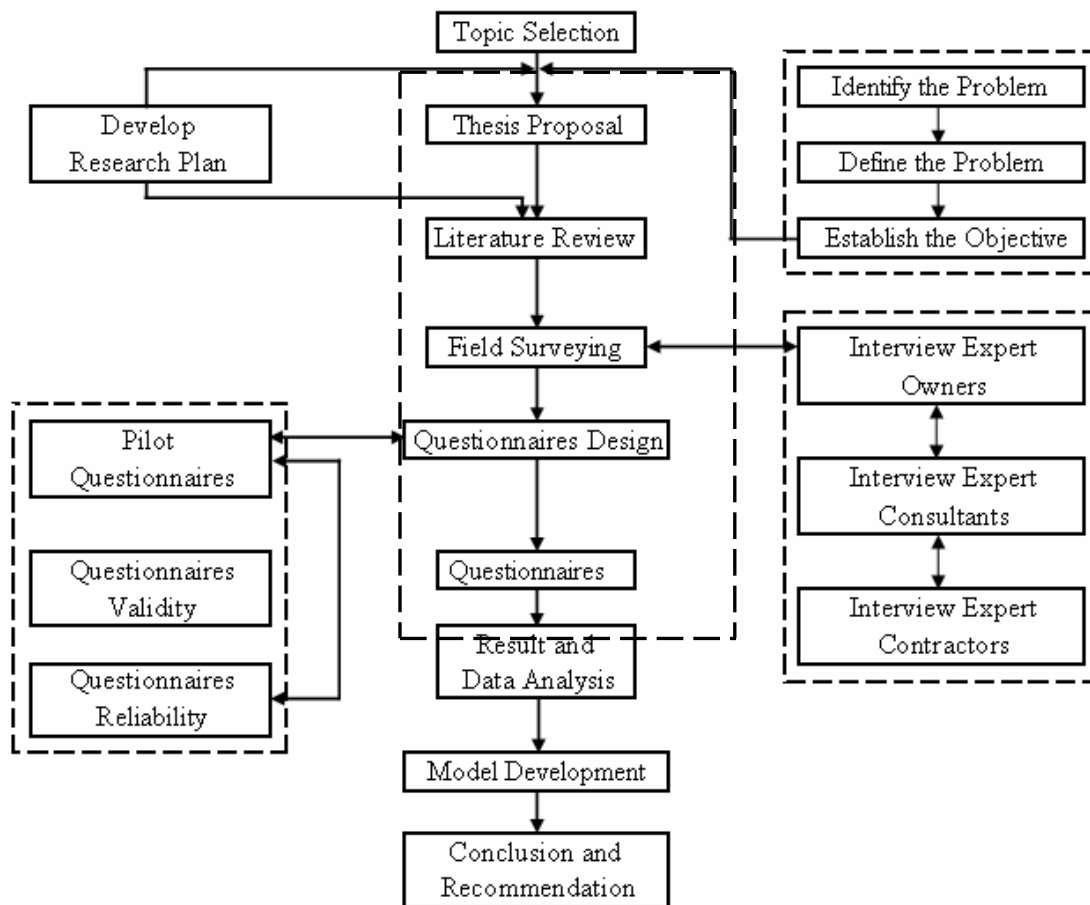


Figure 3.3- Flow-Chart Methodology.

3.8- Determining the Targeted Sample:

The author considers the population for this research as to include three targets:

- The contractors who have a valid registration at the “OEA of North-Lebanon”;
- The consulting engineering offices, which are registered at the “OEA of North-Lebanon”;
- The owners, consisting of mainly private owners, due to the lack of governmental agencies, ministries, municipalities etc. of the public sector executing in the region.

The researcher targets to investigate a “small sample” and to generalize the results to the “entire sample”, (the author).

3.9- The Questionnaire designing approach:

The design of this research’s questionnaire is based on the five-stage approach:

- **Stage -1- “Initial considerations”:** (target population, the sample and the respondents).
- **Stage -2- “Concepts clarification”:** including:
 - Identification of the research concepts;
 - Careful consideration of question wording
 - Preparation of the potential questions’ list.
- **Stage -3- “Typology of the questionnaire”:** (the types and structure of questions used are identified [71]. Two types of questions are possible:
 - Open-ended questions: allowing the respondents to use their wording in the answering.
 - Closed-ended questions: where the respondent has to choose a specific from a set of answers provided.
- **Stage -4- “Pre-testing and Problems Correction”:** (pilot testing to refine the questions making “validity and reliability” effective within the gathered data [114].
- **Stage -5- “Questionnaire distribution”:** to administer the questionnaire.
A sub-section of this stage is the “*questionnaire translation*”;

3.10 – Determining the Critical Success Factors of TQM in construction:

The “Critical Success Factors” are defined as “critical areas of managerial planning and action that must be practiced to achieve effective quality management in a business unit” [153].

The “critical success factors of TQM implementation in construction projects” can be divided into 8 main groups to include: “leadership, quality planning, resource management, process management, customer satisfaction, training and education, continuous improvement, and communication”.

3.11- Questionnaire Set-up:

To determine the TQM critical success factors related to the implementation in the construction industry of North-Lebanon, the use of the quantitative research is selected for economy and time saving, and enhancing confidentiality, supporting internal / external validity, and facilitating analysis [123]. The questionnaire is built upon using “closed questions”, and is split into 3 subdivisions: Organization profile, Sub success factors of TQM implementation in construction projects in Lebanon-North, including 8 main groups, and Main factors of TQM implementation in construction projects in Lebanon-North, including 81 sub factors.

3.11.1- Organization Profile: including the type of the organization, the organization specialties: (Owners, Consultants, Contractors), the organization years of experience, the organization’s size (employees number), the organization classification, the number of executed projects during a certain time period, the type of executed projects and the construction value.

3.11.2- Personal Data: Describing respondents in the construction industry in terms of sex (gender), maturity (age), educational criteria, profession (occupation) and working skills (experience) that reflect the level of skills and knowledge to be transferred in the organization.

3.11.3- Perception of Quality: and how it is expressed in the construction.

3.11.4- Knowledge of TQM: and how much TQM is familiar with the organization and the level to which the TQM implementation is practiced.

3.11.5- Data Acquisition: related to the methods that construction companies use to gather information regarding quality.

3.11.6- Quality in the organization: investigating about quality in construction firms as a clear defined strategy and program.

3.11.7- Main and Sub-Success Factors of TQM in Construction: investigating the level of importance scale related to *Leadership, Resources Management* with human, information, financial, materials and technological resources, *Strategy and Plan, Process Management* with quality process systems, customer relationship management systems and coordination and structure, *Customer Satisfaction, Training and Education, Continuous Improvement, and Communication.*

3.12- Data analysis procedures and methods:

- Triangulation;
- Qualitative data analysis;
- Quantitative data analysis.

3.12.1- Triangulation: Defined as “the combination of methodologies in the study of the same phenomenon” [14]. (Combine qualitative and quantitative methods under a variety of names such as mixed model studies or triangulation).

3.12.2- Qualitative Data Analysis: Qualitative methods are related to data gathering via interviews and personal observations. The core objective is to better understand the subject that helps in problem discussion, data collecting and results’ analyzing which cannot be expressed in numbers.

3.12.3- Quantitative Data Analysis: Quantitative research involves data collection procedures using numerical data that is analyzed by statistical methods [188]. The analysis of quantitative data is relatively much simpler than the qualitative one, since dealing with codes and numbers.

3.12.4- Statistical Methods

A- Statistical inference: Statistical inference is the process by which we acquire information and draw conclusions about population from samples.

- Estimation’s objective: “determination of approximate value of a population parameter on the basis of a sample statistic”.
- Hypothesis testing objective: “determine whether enough statistical evidence exists to enable us to conclude that a hypothesis about a parameter is supported by the data”.

B- Chi Square: The purpose of the use of Chi square is testing the validity of the results obtained from the statistical population comparing to the results obtained from the sample.

The proper test for the current study is the Chi Square test because the goal is to compare one group to hypothetical value and the sample size is around 30 (exactly $N=48$).

3.12.5- Validity and Reliability:

Reliability is defined as “the extent to which a measurement procedure yields the same answer however and whenever it is carried out”. For the purpose of this research internal consistency method is used because it is the most widely used reliable estimate in empirical research [165].

Validity is defined as the extent to which it gives the correct answer [101]. Therefore, the researcher will present the draft of the questionnaires to the specialists to validate and agree to the clarity and accuracy of each statement.

3.12.6- Data Analysis:

Specific statistical methods are used to analyze the data;

- “*Cronbach’s Alpha*” is used to measure internal consistency;
- “*The Relative Importance Index RII*” is used to determine the ranks of all factors.
- “*The Degree of Agreement / Disagreement among raters*”.
- “*The Kruskal Wallis test*” between more than two groups.

CHAPTER 4

PRACTICAL CONTRIBUTION OF THE RESEARCH

4.1- Introduction:

The scope is to focus on analyzing the gathered data from respondents through interviews and questionnaire. The results are structured to conclude the critical success factors and assess the level of importance of the critical success factors using Relative Important Index.

The findings have been presented here in a statistical format such as charts and tables.

4.2- Questionnaire Response rate:

Out of the 75 questionnaires distributed, 52 were returned .However, 4 were found to be invalid for analysis as a result of improper filling yielding an effective response rate of 64% .

4.3- Profile of the respondent organization:

4.3.1- Type of the organization:

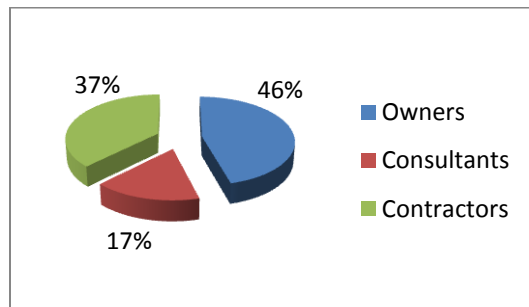


Figure 4.1- Type of Construction Organization

[author]

4.3.2- Specialty of the organization:

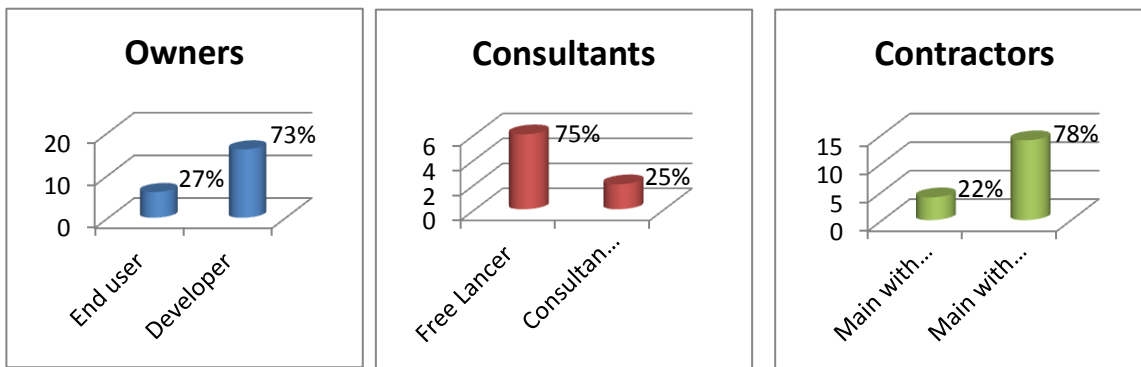


Figure 4.2- Type of Construction Organization Specialty [author]

4.3.3- Age of the organization:

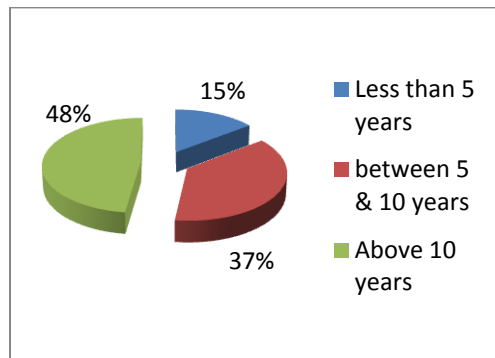


Figure 4.3- Age of the Organization

4.3.4- Number of full time employees:

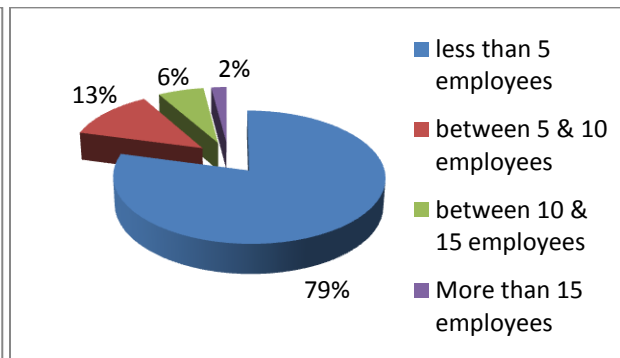


Figure 4.4- Number of full-time employees in the organization [author]

4.3.5- Number of executed projects:

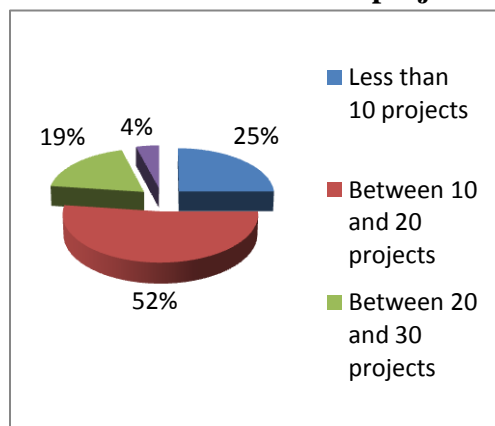


Figure 4.5- Amount of completed projects within the last 10 years [author]

4.3.6- Construction Dollars value:

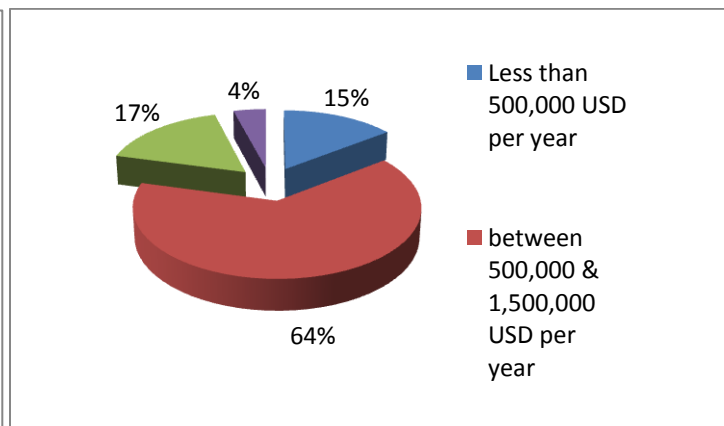


Figure 4.6- Executed projects Value in year 2015 [author]

4.4- Profile of the respondent:

The respondents' profile provides descriptive information on the individual respondents.

4.4.1- Experience of respondents:

Table 4.1- Experience of Respondents [author]

Experience of the respondents (years)	<1	1-3	3-6	6-10	>10	total
Frequency	2	4	15	20	7	48
Percentage (%)	4.2	8.3	31.3	41.7	14.6	100

4.4.2- Occupation of respondents:

Table 4.2- Occupation of Respondents [author]

Occupation of the respondents	Managerial	Supervision	Project Manager	Engineer	Technical	total
Frequency	13	8	15	8	4	48
Percentage (%)	27.1	16.7	31.3	16.7	8.3	100

4.4.3- Educational level of respondents:

Table 4.3- Educational Level of Respondents [author]

Educational Level of the respondents	Bachelor	Masters	PhD	total
Frequency	15	29	4	48
Percentage (%)	31.3	60.4	8.3	100

4.4.4- Age of respondents:

Table 4.4- Age of Respondents [author]

Age of the respondents (years)	<30	30-40	>40	total
Frequency	21	15	12	48
Percentage (%)	43.8	31.3	25.0	100

Summary

In summary, the information detailed above indicates that the respondents and respondents' firms have reasonable experience in the construction field. For that matter it is accurate to conclude that those who responded to the survey are sufficiently experienced to provide data which is reliable and valid.

4.5- Quality management systems:

The Following are the results gathered from the “quality management practices” in the North-Lebanese construction organizations, as owners, developers, consultants and contractors.

4.5.1- Perception of Quality:

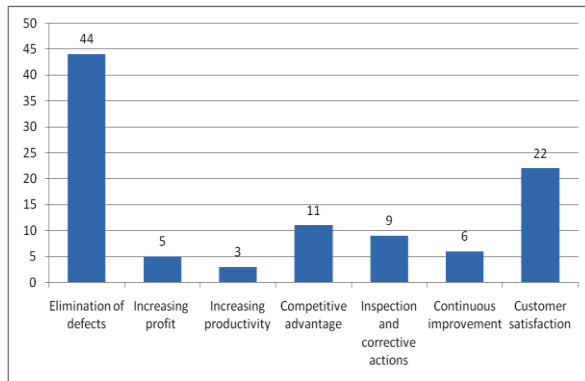


Figure 4.7- Organization's perception of quality[author]

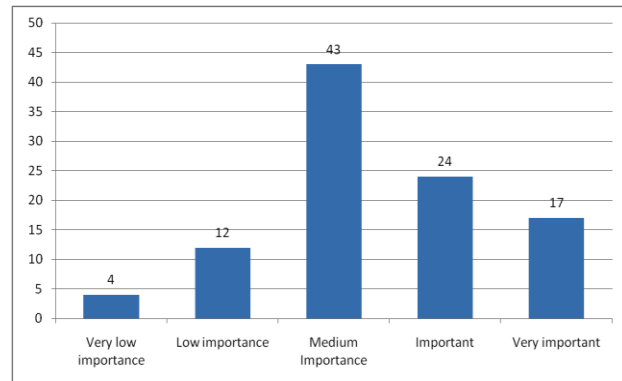


Figure 4.8- Organization rating perception of quality [author]

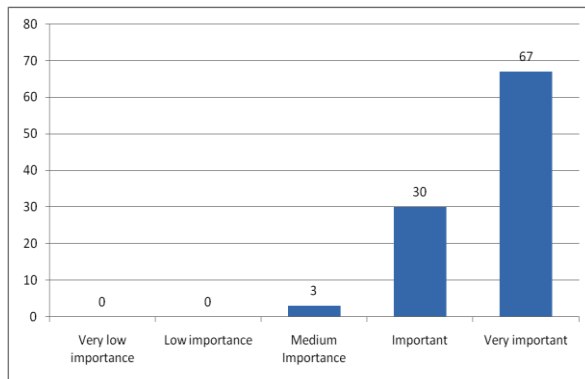


Figure 4.9- Degree of Importance of Product quality [author]

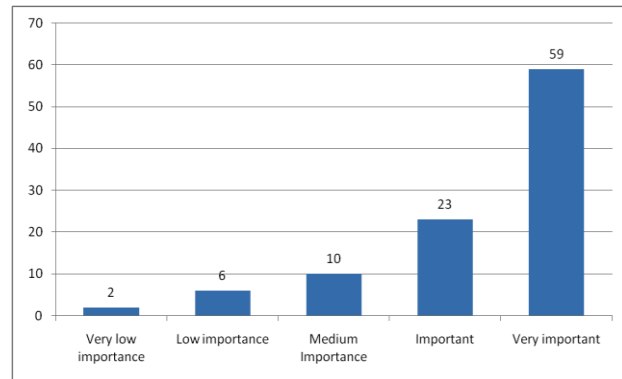


Figure 4.10- Degree of Importance of quality vs. other parameters [author]

Summary

In summary, the gathered responses regarding perception of quality let us see a general interest of the greater part of respondents in quality. The deep-in detailed studies related to quality and its success factors will be developed in the following.

4.5.2- Data Acquisition:

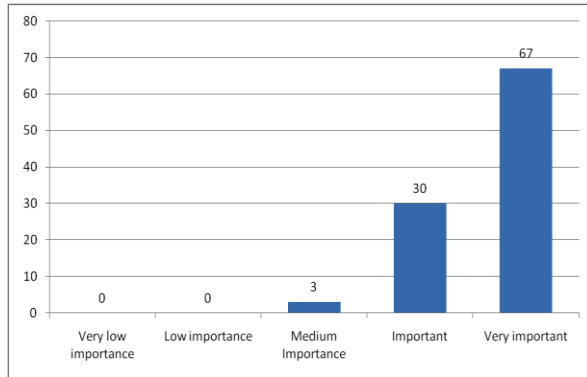


Figure 4.9- Degree of Importance of Product quality [author]

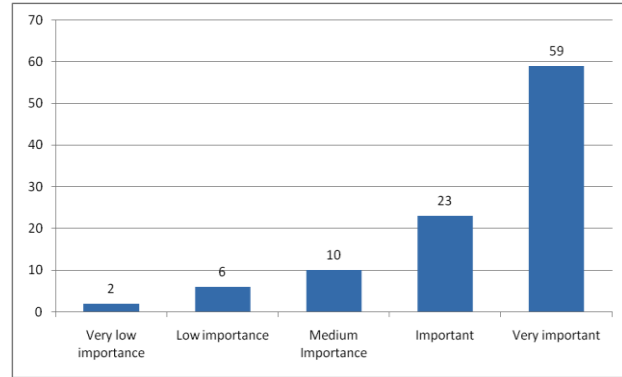


Figure 4.10- Degree of Importance of quality vs. other parameters [author]

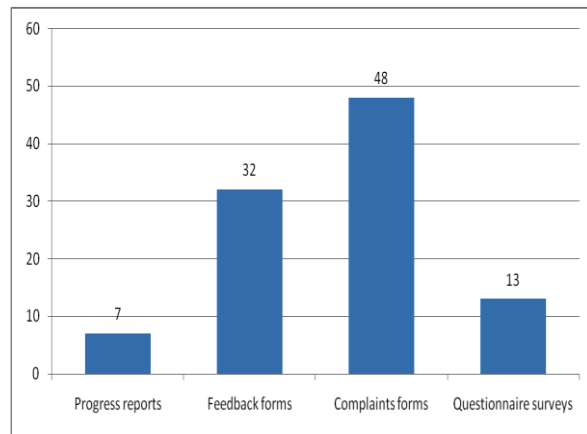


Figure 4.11- Organization data acquisition method [author]

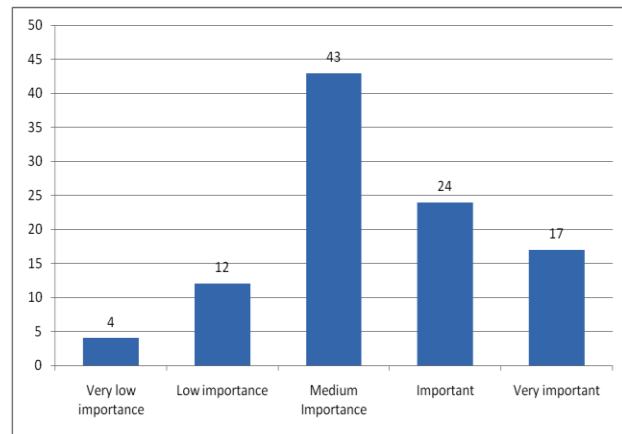


Figure 4.12- Organization rate of customer satisfaction [author]

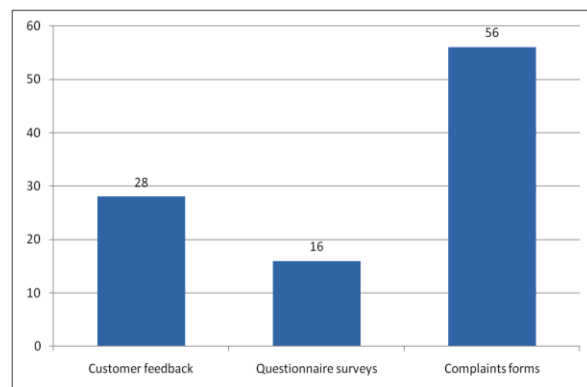


Figure 4.13- Organization customer suggestions [author]

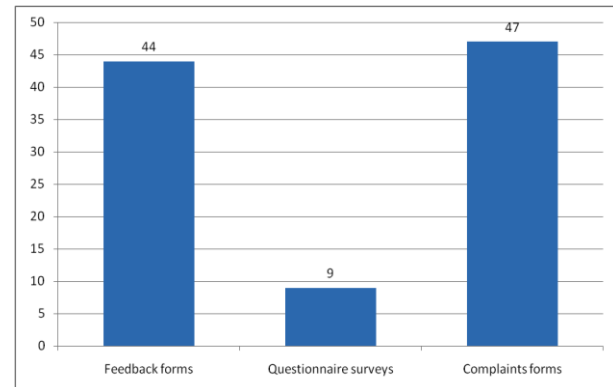


Figure 4.14- Organization employee suggestions [author]

According to the respondents, their organizations adopt the data collection method to evaluate their operations' performance. By majority, the feedback and complaints forms from employees and customers are the preferred methodology in collecting data in their organizations.

4.6- Quality improvement in the organization:

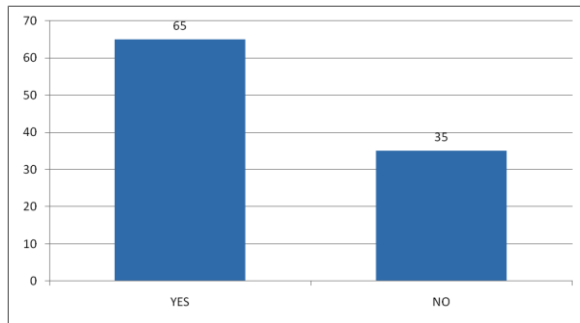


Figure 4.15- Organization with clear definition of quality [author]

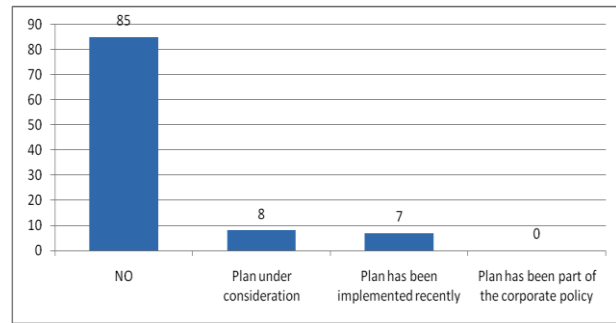


Figure 4.16- Organization implementation of quality improvement program [author]

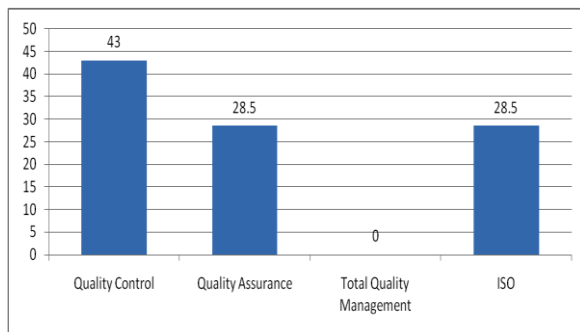


Figure 4.17- “Quality Improvement Program” in organization [author]

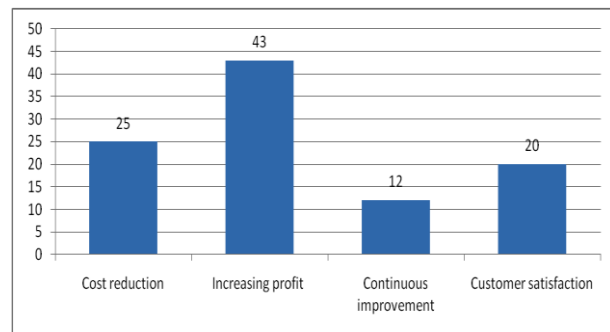


Figure 4.18- Most important goals of the Quality Program [author]

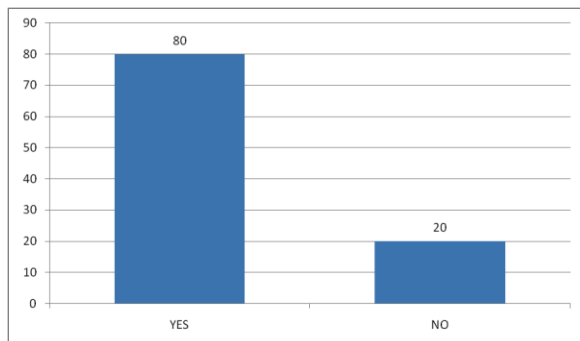


Figure 4.19- Top management support of QIP within organization [author]

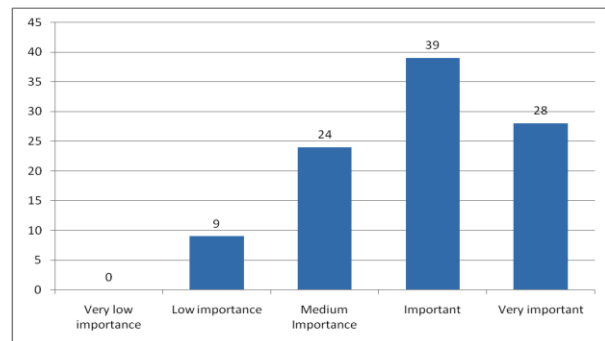


Figure 4.20- Impact degree of QIP on product quality within the organization [author]

Even though 65% of the companies have a clear definition of quality, less than 15% have – or plan to have- a quality improvement program. Although fully supported by the top management, the QIP, once available, is most targeting the quality control QC (48%) and quality assurance QA (28.5%); the major objective is related to profit increase and cost reduction; continuous improvement and customer satisfaction come at a second stage of importance. Majority are convinced that a quality improvement program does have an important impact on quality.

4.7- Knowledge of Total Quality Management:

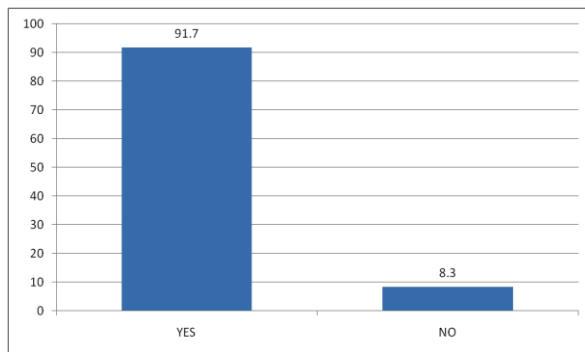


Figure 4.21- TQM possibility of application within organization (%) [author]

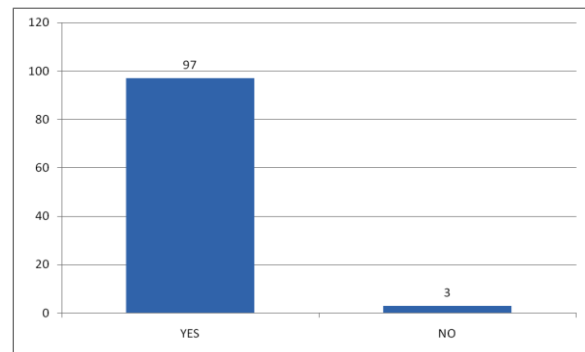


Figure 4.22- TQM program benefit rates (%) [author]

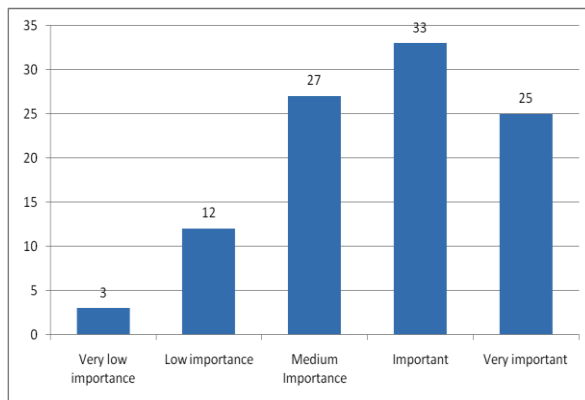


Figure 4.23- Impact of TQM on organization's customers (%) [author]

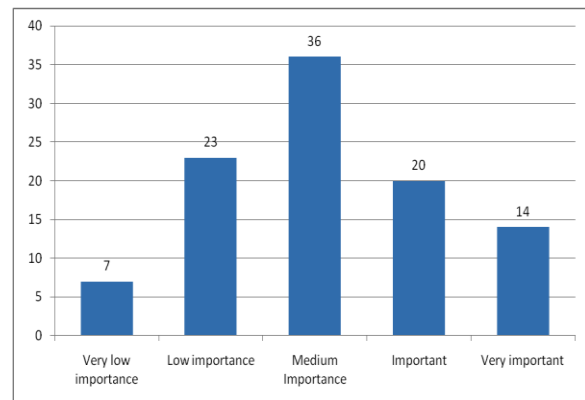


Figure 4.24- Impact of TQM on organization's suppliers (%) [author]

The majority of respondents (92%) agree that TQM can be applied in their organization and it will be very beneficent (97%); also the impact of TQM on organizations' customers is relatively of high importance. Organizations are most likely convinced with the importance of customers rather than the suppliers.

4.8- TQM Critical Success Factors analysis:

The CSFs are “critical areas of managerial planning and action that must be practiced to achieve effective quality management in a business unit”;

The constructs or critical success factors identified in frameworks for TQM, identify both “Soft and hard dimensions of TQM” [53,131,142,144];

- “Hard components of TQM concentrate on the tools and techniques, systems and the supplementary measurement and control of the work process;
- “Soft components relate to areas behavioral concerns.

4.8.1- Sub-Success factors of TQM implementation in construction:

A comparative description of the TQM constructs derived from major studies on TQM is depicted in Table 4.5 [102]

Table 4.5- Summary of Studies on Success factors for TQM Implementation.

Saraph et al. (1989)	Flynn et al. (1994)	Alire et al. (1996)	Black and Porter (1996)	Zhang 2000	Sila& Ebrahimpour (2002)	Kaynak H (2003)	Conca et al(2004)	Sila& Ebrahimpour(2005)	Baidoun & Zairi (2003)	MBNQA (2000)	EFQM model (2004)
Management leadership	Top management support	Top management commitment	Corporate quality culture Strategic quality management	Leadership	leadership and top management commitment	Management leadership	Leadership	Leadership	top management commitment and involvement	Leadership	Leadership
Role of Quality Department											
Training		Employee training		Education and Training	Employee Training	Training	Training				
Employee relations	Workforce management	Employee empowerment	People management	Employee Participation	Employee involvement	Employee relations	Specialist training	Human resource management	top management commitment and involvement	Human resource focus	Employee management
		Employee involvement				Quality data and reporting	Supplier management	Supplier management			Resources
Quality data and reporting	Quality information	Internal quality information usage			quality information and performance	Supplier quality management	Quality information	Internal quality information usage			quality information and performance
Supplier quality management	Supplier involvement	Supplier quality Management & performance	Supplier partnerships	Supplier Quality Management		Product / service design					
Process management	Process management	Design quality management		Process Control & Improvement		Process management	Process management	Process management		Process management	Processes
	Customer involvement	Customer focus	customer management	Customer focus	customer focus and satisfaction		Customer focus	Customer focus	customer driven System	Customer and market focus	
		Benchmarking					Learning				
				Vision and Plan Statement			Continuous Improvement		continuous improvement		
			Teamwork structures		Teamwork		Quality Planning	Strategic Planning		Strategic Planning	Planning and strategy
				Evaluation Quality System Improvement	continuous improvement		Communication				
			Operational quality planning								
		Statistical process control usage		Recognition and Reward							

A- Top Management Commitment:

Table 4.8- Leadership Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Leadership	Impact of strong character of the leaders on the implementation of TQM in construction	0.93	1	0.93	1	0.91	2	0.92	1
	Top-management continuous commitment to quality	0.91	2	0.90	2	0.92	1	0.91	2
	Ability of top management to distribute the responsibilities for quality on the department heads	0.85	4	0.90	2	0.90	3	0.88	3
	Ability of top management to identify the responsibilities for quality performance	0.87	3	0.88	4	0.88	5	0.88	3
	Top management establishing relation between quality and cost/time frame objectives	0.80	6	0.85	5	0.89	4	0.84	5
	Top management consider quality culture when dealing with customers and suppliers	0.82	5	0.83	6	0.88	5	0.84	5
	Top management supporting total quality within the culture of the organization	0.79	7	0.78	8	0.87	7	0.82	7
	Top management involvement in total quality objective, task definition, budgeting, and measurement	0.76	9	0.80	7	0.86	8	0.80	8
	Top management supporting total quality by provision of appropriate resources and assistance, and allocating adequate timing for it	0.77	8	0.75	9	0.83	10	0.79	9
	Top management involvement in setting up a long term vision of quality approach	0.75	10	0.73	11	0.84	9	0.78	10
	Top management learning from problems	0.74	11	0.73	10	0.83	10	0.77	11

B- Resources Management:

- Human Resource Management:**

Table 4.9- Human Resources Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Human Resources	The organization pocesses incentive systems related to quality	0.91	1	0.90	2	0.89	1	0.90	1
	There is a methodology for gathering information and analyzing it (in terms of quality);	0.86	2	0.93	1	0.86	2	0.87	2
	There is a specific recruitment strategy in terms of quality of the employee?	0.76	4	0.85	4	0.81	3	0.80	3
	There is training needs and evaluation of them	0.72	5	0.88	3	0.78	4	0.77	5
	There is a suggestions and complaints system within the organization	0.80	3	0.83	5	0.71	5	0.77	4

- **Information Resource Management:**

Table 4.10- Information Resources Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Information Resources	An Information system is available within the organization	0.82	1	0.83	1	0.82	1	0.82	1
	The information system covers most of the duties	0.80	2	0.80	2	0.78	2	0.79	2
	There is a program for specifying the needs for information system	0.75	3	0.73	3	0.71	3	0.73	3

- **Financial Resource Management:**

Table 4.11- Financial Resources Sub-CSF Factor according to respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Financial Resources	there are plans and scopes to increase income and cut down on expenditure	0.91	1	0.83	2	0.92	1	0.90	1
	there exists a methodology for preparing budget in the organization	0.86	2	0.85	1	0.82	2	0.85	2
	The company sticks to the budget	0.75	4	0.75	3	0.80	3	0.77	3
	There is corrective action to control project cost and expenses	0.82	3	0.75	3	0.70	4	0.76	4
	The financial costs and expenses are related to re-work due to poor quality	0.74	5	0.68	6	0.69	6	0.71	5
	The company applies the "Bonus" incentives to employees of good quality services	0.72	6	0.70	5	0.70	4	0.71	5

- **Material Resource Management:**

Table 4.12- Material Resources Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Material Resources	The company is interested in material resource management	0.72	5	0.80	1	0.80	2	0.76	4
	The company has an effective purchase system to satisfy the demand during period of replenishment	0.80	3	0.78	2	0.83	1	0.81	2
	The company has a storage system	0.88	1	0.75	3	0.78	3	0.82	1
	There is a method for specifying the required material	0.85	2	0.73	4	0.78	3	0.80	3
	The system is friendly-user	0.75	4	0.70	5	0.71	5	0.73	5

- **Technological Resource Management:**

Table 4.13- Technological Resources Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Technological Resources	The company shows interest in applying new technologies	0.76	2	0.85	1	0.82	1	0.80	1
	The company invests in adopting up-to-date technological tools and machines	0.72	3	0.83	2	0.80	2	0.77	3
	The investment in new technology resources is considered a plus for the organization	0.80	1	0.78	3	0.77	3	0.78	2
	There is a methodology for transferring technology and focusing on research and development	0.70	4	0.75	4	0.72	4	0.72	4
	There is any adopted system for the best use of technology within the organization	0.65	5	0.73	5	0.72	4	0.69	5

C- Strategy and Planning

Table 4.14- Strategy and Planning Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Strategy and Planning	There are well identified goals in the organization	0.93	1	0.90	1	0.91	1	0.92	1
	There is a strategic base on the concept of overall quality management	0.91	2	0.88	2	0.87	3	0.89	2
	The organization's mission and vision are well stated	0.87	3	0.83	4	0.88	2	0.87	3
	There are control and improvement of the organization plans	0.80	5	0.85	3	0.84	4	0.83	4
	The communication strategies are well structured and of big importance	0.77	6	0.78	6	0.81	5	0.79	6
	Customers and their needs are well determined and specified	0.85	4	0.80	5	0.78	6	0.81	5

D- Process Management

- **Quality Process Management:**

Table 4.15- Quality Process System Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Quality Process Management	The project's objectives are well determined	0.91	1	0.80	6	0.89	2	0.88	2
	The project is well programmed in terms of timing	0.85	2	0.93	1	0.96	1	0.90	1
	The project conform to safety regulation and process	0.71	9	0.90	2	0.84	4	0.79	4
	The project sticks to owner's requirements	0.82	3	0.88	3	0.87	3	0.85	3
	The project conforms to codes and standards	0.68	10	0.85	4	0.78	6	0.75	7
	These codes are applied during all phases of the project	0.66	11	0.68	11	0.76	7	0.70	11
	The project is subject to a control system (third party)	0.77	5	0.70	10	0.80	5	0.77	5
	The project conform to design processes and procedures	0.72	8	0.83	5	0.71	9	0.73	8
	The project conforms to specifications	0.74	7	0.75	9	0.69	10	0.72	10
	The project conforms to calculation standards	0.75	6	0.80	6	0.67	11	0.73	9
	The project have engineering drawings based on local standards	0.80	4	0.78	8	0.73	8	0.77	5

- Customer relationship Management:**

Table 4.16- Customer relationship Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Customer Relationship Management	There is a specific system that relates with the customer	0.68	4	0.85	1	0.76	2	0.74	4
	There is an adequate methodology of gathering and analyzing customer's information	0.72	3	0.80	2	0.81	1	0.77	2
	There is a specific system to specify customer's needs	0.84	1	0.75	3	0.72	3	0.78	1
	There is a specific system for customer's suggestions and complaints	0.78	2	0.73	4	0.71	4	0.75	3

- Coordination and Structure:**

Table 4.17- Coordination and structure Sub-CSF according to respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Coordination and Structure	There is a clear job description for all employees	0.85	1	0.88	1	0.89	1	0.87	1
	There is a mechanism of coordination between different project parties and levels	0.80	2	0.80	3	0.86	2	0.82	2
	There is an adequate methodology for setting and improving the organization structure	0.75	5	0.85	2	0.83	3	0.80	3
	There is a specific mechanism for ensuring coordination	0.79	3	0.80	3	0.78	5	0.79	4
	There is a methodology for authority delegation	0.77	4	0.78	5	0.81	4	0.79	4

E- Customer Satisfaction:

Table 4.18- Customer Satisfaction Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Customer Satisfaction	Company's customer satisfaction rating system	0.72	5	0.73	5	0.76	4	0.73	5
	There is repetitive work with the same customer	0.87	2	0.88	2	0.82	3	0.85	2
	The response time for customer requests is well rated	0.84	3	0.75	4	0.73	5	0.78	4
	The adopted plan of work is exactly achieved	0.91	1	0.90	1	0.89	1	0.90	1
	The contractor has good abilities and skills to cooperate with other contractors, workers and supervisors	0.78	4	0.83	3	0.88	2	0.83	3

F- Training and Education:

Table 4.19- Training and Education Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Training and Education	The company has a clear vision of the important goals that training and education can meet; Specifically in terms of quality.	0.80	1	0.88	1	0.84	1	0.83	1
	The organization is committed to quality training and education programs	0.71	4	0.70	4	0.80	2	0.74	3
	There is a continuous training in the "total quality concept"	0.66	6	0.68	5	0.69	6	0.68	6
	Resources for employee training in the company are available	0.75	2	0.83	2	0.78	3	0.78	2
	Employees evaluation of quality trainings in their companies	0.72	3	0.78	3	0.73	4	0.73	4
	There is training on quality tools and techniques in solving problems	0.68	5	0.68	5	0.71	5	0.69	5

G- Continuous Improvement:

Table 4.20- Continuous Improvement Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Continuous Improvement	There is a regular evaluation of the quality of the operating system	0.80	3	0.85	1	0.80	2	0.81	2
	The root causes when diagnosing the system malfunction are well searched	0.86	1	0.83	2	0.82	1	0.84	1
	The operating system malfunctions are related to quality	0.77	5	0.75	6	0.72	5	0.75	5
	Quality behavioral change within the time	0.72	6	0.78	5	0.70	6	0.72	6
	There is a teamwork within the organization	0.84	2	0.80	3	0.78	3	0.81	2
	There is a ranking system for the quality of data which is used to evaluate supervisor and managerial performance.	0.78	4	0.78	4	0.76	4	0.77	4

H- Communication

Table 4.21- Communication Sub-CSF according to all respondents [author]:

Critical success factor	Item	Owners		Consultants		Contractors		Overall Respondents	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Communication	Good communication between different departments	0.82	1	0.80	2	0.84	1	0.83	1
	Same technical language between departments	0.75	4	0.75	4	0.71	5	0.74	4
	Effective top-down and bottom-up communication	0.78	2	0.83	1	0.81	2	0.80	2
	Formal feedback	0.76	3	0.78	3	0.78	3	0.77	3
	Quality techniques/tools to solve problems	0.71	5	0.73	5	0.76	4	0.73	5

4.8.2- Main-Success factors of TQM implementation in construction:

Table 4.22- Main Critical Success Factors according to all respondents [author]:

Main Critical Success Factors		Owners		Consultant		Contractor		Overall	
		RII	RANK	RII	RANK	RII	RANK	RII	RANK
Total Quality Management	Leadership	0.817	3	0.822	3	0.873	1	0.839	2
	Human Resources	0.811	4	0.875	1	0.809	5	0.821	3
	Information Resources	0.791	9	0.783	9	0.770	10	0.782	8
	Financial Resources	0.8	5	0.758	12	0.772	9	0.782	8
	Material Resources	0.8	5	0.75	14	0.78	7	0.784	6
	Technological Resources	0.725	13	0.785	8	0.766	11	0.751	13
	Strategy and Planning	0.855	1	0.837	2	0.848	2	0.849	1
	Quality Process Management	0.764	11	0.806	6	0.789	6	0.781	10
	Customer relationship	0.755	12	0.781	10	0.75	14	0.757	12
	Coordination and Structure	0.792	8	0.82	4	0.833	3	0.812	5
	Customer satisfaction	0.823	2	0.815	5	0.815	4	0.819	4
	Training and Education	0.721	14	0.754	13	0.759	13	0.741	14
	Countinuous Improvement	0.795	7	0.796	7	0.763	12	0.783	7
	Communication	0.765	10	0.77	11	0.78	7	0.771	11

It appears necessary to evaluate the degree of agreement among the different groups relative to the implementation of total quality management in construction; In order to do so, statistical measurements will be applied;

- The use of Kendall Coefficient of concordance, to measure agreement among raters;
- The Kruskal-Wallis coefficient is used to compare between ranks means of samples.

4.9- Statistical measurements and analysis:

4.9.1- Internal Consistency and Reliability:

Table 4.23- Cronbach's Alpha according to all respondents [author]:

Main Critical Success Factors		Cronbach's Alpha			
		Owners	Consultant	Contractor	Overall
Total Quality Management	Leadership	0.918	0.944	0.975	0.944
	Human Resources	0.824	0.906	0.912	0.863
	Information Resources	0.742	0.653	0.875	0.797
	Financial Resources	0.836	0.881	0.901	0.9
	Material Resources	0.879	0.949	0.922	0.891
	Technological Resources	0.94	0.833	0.928	0.923
	Strategy and Planning	0.769	0.909	0.931	0.899
	Quality Process Management	0.909	0.955	0.948	0.914
	Customer relationship	0.76	0.847	0.887	0.738
	Coordination and Structure	0.942	0.922	0.943	0.937
	Customer satisfaction	0.758	0.896	0.913	0.812
	Training and Education	0.916	0.917	0.924	0.95
	Countinuous Improvement	0.913	0.948	0.919	0.958
	Communication	0.907	0.952	0.933	0.921

4.9.2- Degree of agreement among the different types of organizations:

The calculated Kendall's coefficients of concordance for each field are listed in Table 4.24.

“Null Hypothesis - H0: There is an insignificant degree of agreement among the owners, contractors and consultant”.

“Alternative Hypothesis - H1: There is a significant degree of agreement among the owners, contractors and consultants”.

Table 4.24- Kendall's Coefficient, Chi-Square, and decisions for each field [author]:

Total Quality Management	Field of Survey	W	χ^2	P-value	Decision
	Leadership	0.949	28.49	0.00	P<0.05 -----> Reject H0
	Human Resources	0.777	9.33	0.01	P<0.05 -----> Reject H0
	Information Resources	1	6	0.05	P=0.05 -----> Reject H0
	Financial Resources	0.856	12.84	0.00	P<0.05 -----> Reject H0
	Material Resources	0.4311	5.17	0.08	P>0.05 -----> Adopt H0
	Technological Resources	0.742	8.9	0.01	P<0.05 -----> Reject H0
	Strategy and Planning	0.86	12.9	0.00	P<0.05 -----> Reject H0
	Quality Process Management	0.611	18.33	0.00	P<0.05 -----> Reject H0
	Customer relationship	0.2	2.4	0.30	P>0.05 -----> Adopt H0
	Coordination and Structure	0.675	8.1	0.02	P<0.05 -----> Reject H0
	Customer satisfaction	0.822	9.86	0.01	P<0.05 -----> Reject H0
	Training and Education	0.833	12.5	0.00	P<0.05 -----> Reject H0
	Countinuous Improvement	0.911	13.66	0.00	P<0.05 -----> Reject H0
	Communication	0.911	10.93	0.01	P<0.05 -----> Reject H0
The agreement is significant at level of significant $\alpha = 0.05$					

4.9.3- Kruskal Wallis non-parametric test:

By definition, “The Kruskal-Wallis coefficient KW is used to compare between ranks means of two or more samples; this test is used in order to examine if there are any significant differences in the point of view of the respondents regarding the levels of each of the factors”.

“Null Hypothesis - H0: There is a significant difference between the organization types (owners, contractors and consultants) regarding their responses to all fields of TQM”.

“Alternative Hypothesis - H1: There is No-significant difference between the organization types (owners, contractors and consultants) regarding their responses to all fields of TQM.”

Table 4.25- Kruskal Wallis test, and decisions for each field [author]:

Nb	Field of survey	KW	P-value
1	Leadership	4.808	0.091
2	Human Resources	2.960	0.227
3	Information Resources	0.289	0.866
4	Financial Resources	1.064	0.587
5	Material Resources	2.340	0.306
6	Technological Resources	0.485	0.788
7	Strategy and Planning	0.272	0.872
8	Quality Process Management	1.611	0.448
9	Customer relationship	1.038	0.595
10	Coordination and Structure	2.940	0.230
11	Customer satisfaction	0.020	0.990
12	Training and Education	1.289	0.525
13	Countinuous Improvement	1.719	0.424
14	Communication	0.320	0.853

4.10- Proposal of TQM Implementation's Framework:

Our proposed TQM framework consists of 5 phases, designed to help North-Lebanese construction companies to move forward towards TQM culture. Following, the critical success factors identification and weighing impact are determined as a measuring model.

4.11- Need for a TQM Framework:

The need for a TQM implementation framework can be related to [1]:

- Good presentation of TQM addressing new organization’s vision;
- Engaging managerial definition of main topics and ideas according to TQM approach;
- Detecting organization's strengths and weaknesses;
- Supporting the implementation of TQM for successful adoption.

4.12- TQM Framework Design Requirements:

Developing an efficient framework matching the need of the construction industry, necessitate the following design criteria [184]:

- Is well structured and organized;
- Is methodological;
- Presents an ease of understanding;
- Has well inter-linked elements;
- Represents a “road map” to a smooth implementation;
- Can be considered as “planning tools” for application;
- Answering “how to”.

4.13- TQM Framework Development:

The phases’ process of implementing TQM in Local North Lebanese Construction Companies can be summarized as follows:

- Phase “O” – Knowing Quality- to include:
 - Change of Mentality and Culture;
 - Leadership Learning Need.
- Phase “1” – Commitment and Preparation - to include:
 - Top Management Commitment;
 - Appointing Quality Manager;
 - Training at all levels;
 - Facilitators and Improvement teams;
 - TQM steering committee;
 - Review of organization’s status;
 - Create TQM vision.
- Phase “2” – Implementation of TQM - to include:
 - Determining Performance Criteria;
 - Identification of Critical Success Factors;
 - Value-weighing of the CSFs;
- Phase “3” – Scheme for Improvement - to include:
 - Problem solving methodology;
 - Statistical Process Control.
- Phase “4” – Measurement for Improvement - to include:
 - Feedback on the Company Goal;
 - Overall business performance measures and comparison.

4.14- Model Measuring TQM in Construction:

4.14.1- Model Development Steps:

The here-below listed steps are tracked in the development of the current model:

- Importance Percentages of the “main critical success factors of TQM implementation in construction”;
- Importance Percentages of “sub-factors under groups’ factors and their impact on TQM implementation in construction”;
- Organizing the sub-factors percentages related to “TQM implementation” in a descending arrangement;
- Pareto analysis of the results, applicability and discussion.

A- Importance Percentages of the main critical success factors:

The following equation 4.1 is utilized to find out the importance percentages of the main critical success factors influencing TQM implementation in North-Lebanese construction firms:

$$P_i = \frac{RII_i}{\sum_{i=1}^n RII_i} \times 100, (100\%) \quad (4.1)$$

Where:

P_i - is the importance percentage of the main factor (i)

RII_i - is the relative importance index of the (i)th main critical success factor

n - is the number of main critical success factors.

Table 4.26- Importance Percentages of Main Critical Success Factors [author]:

No	Main Critical Success Factors	RII _i	P _i
1	Leadership	0.839	7.578
2	Human Resources	0.821	7.415
3	Information Resources	0.782	7.063
4	Financial Resources	0.782	7.063
5	Material Resources	0.784	7.081
6	Technological Resources	0.751	6.783
7	Strategy and Planning	0.849	7.668
8	Quality Process Management	0.781	7.054
9	Customer relationship	0.757	6.837
10	Coordination and Structure	0.812	7.334
11	Customer satisfaction	0.819	7.397
12	Training and Education	0.741	6.693
13	Countinuous Improvement	0.783	7.072
14	Communication	0.771	6.964
	TQM	SUM(RII _i)= 11.072	SUM(P _i)= 100

B- Importance Percentages of sub-factors under main critical success factors:

The following equation 4.2 is utilized to find out the importance percentages of the sub-factors under main critical success factors according to their impact on the TQM implementation in North-Lebanese construction firms:

$$P_k = \frac{RII_k}{\sum_{k=1}^m RII_k} \times P_i \quad \text{Where:} \quad (4.2)$$

P_k - is the importance percentage of the sub-factor (k)

P_i - is the importance percentage of the main factor (i)

RII_k - is the relative importance index of the (k)th sub-critical success factor

m - is the number of sub-factors under a specific main critical success factor.

C- Organizing the sub-factors percentages in a descending arrangement:

Table 4.28- Modified Importance % of Sub-factors with their main groups [author]:

Main Group	Factor	Modified Sub-Factor % related to TQM
Leadership	Impact of strong character of the leaders on the implementation of TQM in construction	0.835
	Top-management continuous commitment to quality	0.828
	Ability of top management to distribute the responsibilities for quality on the department heads	0.794
	Ability of top management to identify the responsibilities for quality performance	0.794
Human Resources	The organization has incentive systems related to quality	1.797
	There is a methodology for gathering information and analyzing it (in terms of quality);	1.739
	There is a specific recruitment strategy in terms of quality of the employee?	1.589
	There is a suggestions and complaints system within the organization	1.539
	There is training needs and evaluation of them	1.531
Information Resources	An Information system is available within the organization	2.732
	The information system covers most of the duties	2.635
	There is a program for specifying needs for information system	2.441
Financial Resources	there are plans and scopes to increase income and cut down on expenditure	1.496
	there exists a methodology for preparing budget in organization	1.406
	The company sticks to the budget	1.282
	There is corrective action to control project cost and expenses	1.268
	The financial costs and expenses are related to re-work due to poor quality	1.178
	The company applies the "Bonus" incentives to employees of good quality services	1.178

Table 4.28- Modified Importance % of all Sub-factors with their main groups –
Continued [author]:

Main Group	Factor	Modified Sub-Factor % related to TQM
Material Resources	The company has a storage system	1.639
	The company has an effective purchase system to satisfy the demand during period of replenishment	1.614
	There is a method for specifying the required material	1.597
	The company is interested in MR management	1.522
	The system is friendly–user	1.456
Technological Resources	The company shows interest in applying new technologies	1.598
	The investment in new technology resources is considered a plus for the organization	1.564
	The company invests in adopting up-to-date technological tools and machines	1.531
	There is a methodology for transferring technology and focusing on research and development	1.431
	There is any adopted system for best use of technology within organization	1.373
Strategy & Planning	There are well identified goals in the organization	1.525
	There is a strategic base on the concept of overall QM	1.476
	The organization's mission and vision are well stated	1.442
	There are control and improvement of the organization plans	1.372
	Customers and their needs are well determined and specified	1.351
	The communication strategies are well structured and of big importance	1.310
Quality Process Manag.	The project is well programmed in terms of timing	0.817
	The project's objectives are well determined	0.802
	The project sticks to owner's requirements	0.768
Customer Relationship Management	There is a specific system to specify customer's needs	1.944
	There is an adequate methodology of gathering and analyzing customer's information	1.913
	There is a specific system for customer's suggestions and complaints	1.861
	There is a specific system that relates with the customer	1.840

Table 4.28- Modified Importance % of all Sub-factors with their main groups Cntd

Main Group	Factor	Modified Sub-Factor % related to TQM
Coordination & Structure	There is a clear job description for all employees	1.729
	There is a mechanism of coordination between different project parties and levels	1.638
	There is an adequate methodology for setting and improving the organization structure	1.596
	There is a specific mechanism for ensuring coordination	1.571
	There is a methodology for authority delegation	1.571
Customer Satisfaction	The adopted plan of work is exactly achieved	1.797
	There is repetitive work with the same customer	1.705
	The contractor has good abilities and skills to cooperate with other contractors, workers and supervisors	1.647
	The response time for customer requests is well rated	1.564
	Company's customer satisfaction rating system	1.464
Training and Education	The company has a clear vision of the important goals that training and education can meet; Specifically in terms of quality.	1.380
	Resources for employee training in the company are available	1.290
	The organization is committed to quality training and education	1.234
	Employees evaluation of quality trainings in their companies	1.220
	There is training on quality tools in solving problems	1.151
	There is a continuous training in the "total quality concept"	1.123
Continuous Improvement	The root causes of system malfunction are well searched	1.400
	There is regular evaluation of quality of the operating system	1.344
	There is a teamwork within the organization	1.344
	There is a ranking system for the quality of data which is used to evaluate supervisor and managerial performance.	1.282
	The operating system malfunctions are related to quality	1.247
	Quality behavioral change within the time	1.199
Communication	Good communication between different departments	1.644
	Effective top-down and bottom-up communication	1.594
	Formal feedback	1.536
	Same technical language between departments	1.470
	Quality techniques/tools to solve problems	100

4.14.2- Final Model for Measuring TQM in construction:

In reference to the above listed values in the table 4.28, we can summarize our proposed model for measuring the TQM implementation in construction as indicated in the figure 4.26:



Figure 4.26- Model Measuring TQM in Construction [author]

CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS AND FUTURE CONCERN

5.1 –Introduction:

This thesis study has identified and addressed the critical parameters related to the implementation of “TQM in the construction” North-Lebanese market. The main aim of the study can be summarized in developing and presenting a “new model” that may help the construction industry apply a TQM framework in different processes at different sections and levels of the company. The following provides conclusions and recommendations based on the findings of this research work. Future concerns are also brought to fore.

5.2 –Conclusions:

In reference to the questionnaire and interview results, conclusions can be listed as follows:

- Local North-Lebanese construction firms were found to have a low level of TQM concepts especially in terms of critical success factors where most construction companies are small to medium enterprises having lack of knowledge of quality management systems, lack of managerial commitment towards quality and poor strategic vision, and miss the tools and techniques for appropriate application.
- Quality practices in local market are still at the very early stages with no clear “quality vision”; the adoption of ISO 9000:2015 is a result of international competition and pressure.
- TQM implementation in the local firms appears to be difficult with the existing stubborn managements and culture (culture change too difficult to change).
- The role to be played by the local government emphasizing the quality culture and environment, by enforcing quality concepts in all sectors, specifically in construction.

As a result from the **Model Measuring TQM in Construction**, the following objectives were achieved:

- The “critical success factors” that affect quality during project phases were defined;
- The “degree of consistency” related to “quality perceptions” between different types of organizations was discussed, and there is a “significant degree of agreement” among the different organizations’ types;
- The “relative weights of the impacting factors” were derived to facilitate the TQM implementation.

5.3 –Recommendations:

Upon the current research’s findings, recommendations towards improving quality concepts in North-Lebanese construction companies can be summarized as follows:

- **Building New Culture:** Shifting towards fresh managerial procedures appears to be a necessity in the North –Lebanese construction companies; in fact, the new conceptual approach in regard to “Quality” has to take place.
- **Start with Belief and Commitment:** The start of the “TQM Journey” shall be based on top-management solid trust, certainty and commitment to the TQM philosophy. Once convinced, diffusion to other levels and personnel occurs.
- **Awareness:** Being aware and of full understanding of the TQM principles and approaches in order to establish the vision, and motivate the employees and workers to fulfill the organization’s goal.

- **Training:** As for quality regard, training shall focus on “problem identification and solving skills”, on “effective communication”, on “teamwork” and “continuous improvement”.
- **Empowerment:** Whenever such empowerment is missing, the TQM implementation is found to fall. To be efficient, employees should be let with some authority, data and knowledge;
- **Plans:** The successful implementation of TQM within the organization necessitates a general plan to be set and applied. Regular evaluation and assessment for the plan should be done.
- **Implement TQM via Critical Success Factors:** To facilitate the TQM approach implementation, it is a must to:
 - Settle the critical success factors; (as derived in this research);
 - Investigate the cost of each TQM success factor;
 - Qualify contractors and consider TQM as criteria in rewarding contracts.

5.4 –Future Concerns:

Different subjects for other researches can be listed:

- Replication of the study in different sectors (education, health, tourism...) to assess the quality levels and its implementation in these sectors and propose the foreseen developments and improvements.
- Exploring the core role that managerial employees have to play for the good introduction of quality concepts and approaches, either at top or at middle level management, and how to interact to catalyze the TQM implementation.
- Studying the TQM adoption in construction companies and its impact on the surrounding environment, discussing the sustainable developments and the exact role supported by the TQM implementation.
- Exploring the participation and role of the Order of Engineers in the local market in establishing a quality culture and initiatives towards better competitiveness and higher engineering levels.
- Exploring the effectiveness of introducing the quality culture at the university studying degrees and its impact on engineering constructions.
- Other studies can be achieved in other countries to get from their particularities and practices.