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Applying ISO 9001:2000 in a Software Development Environment

The case of SecurSoftware Corporation

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Approval Certificate

Applying ISO 9001:2000 in a Software Development Environment

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DECLARATION

I hereby declare that this thesis is entirely my own work and that it has not been submitted as an exercise for a degree at any other University.

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ABSTRACT

Global competition and increasing customer awareness have made the quality as the key indicator for customer requirements and satisfaction as well as a success factor to achieve competitive advantage. Under these circumstances, companies try to become quality leadership companies and start to implement certain quality management approaches.

Consequently, this research analyzes the production processes of a Lebanese company- SecurSoftware- operating in the information technology industry and facing deficiencies in its software production management.

The objective of this research is to provide the company with a better understanding of the well known international standard ISO 9001 and show the benefits the company can get from implementing a quality management system in compliance with ISO 9001:2000.

This study begins by gathering information about the current company situation. It limits its research on the company's core department, which is the technical one. After brainstorming all data resulted from the analysis of the company's available archive and meeting employees with critical jobs hence with critical observations and comments, the study proposes a new strategy model for the company to follow.

An entire chapter is specialized to the ISO implementation project plan. A detailed plan is proposed explaining all needed resources for each step. Moreover, the study designs the 3 main processes of the technical department based on the ISO 9001:2000 requirements. Each process is drawn as a flowchart together with the advantages it provides to the company.

Chapter 4 tests the hypothesis: if SecurSoftware implements a quality management system, it will improve its operational efficiency and capacity. This hypothesis is accepted based on an analysis of the development of an application taken from the company's database, comparing the old system vs. the proposed one.

Finally, the limitations faced when working on this research and recommendations for SecurSoftware top management will conclude this research.

***Keywords**: ISO 9001:2000, Process Management Strategy, Software life cycle, software quality.*

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In the line of pursuit for finishing my thesis, I went through many interesting experiences. Experiences that triggered my passion for a higher education.

Dr. Atef Harb, Dr. Mary Kheir, my parents, my husband and finally the birth of my baby boy, played all a major role_each in his/her own perception_ in directing me toward the end of the line and finally to reach this stage.

I would like to thank every one of you for your support, pushing me side to side only to keep me parallel to my line and focused on my target.

Chapter 1

Introduction

This chapter outlines the main topics dealt with in this study. It starts by explaining the reason that led the top management of a Lebanese software firm to solicit a study that analyzes an implementation of a quality management system[1] in their company. Needs and purposes of this study will give a global idea about advantages the company will benefit from if the QMS will be applied.

1.1 General Background

In the last few years, development organizations recognized that software development has moved beyond the capabilities of individual programmers to become an engineering activity performed by teams, and that the quality of a software product is highly dependent on the quality of the process used to develop it.

SecurSoftware- a Lebanese company operating in the software industry- is very aware of the importance the production of a quality product is, as well as the impact that the latter has on the market that sells in and in the eyes of the buyers. Being also aware of the weaknesses in their software production management and deficiencies in the company's operations, the top management is asking for a change that makes the company in a position to compete with reputable firms in the local market and the international ones- mainly Dubai and Saudi Arabia where their software applications were already introduced.

SecurSoftware failure to optimize its operations' capacity and efficiency using their old system gives no solution but to redesign the whole structure of the company again. This structure should integrate quality from the very early stages of production. The "how" is the focus of this research.

The study presents a simple procedure that drives SecurSoftware management members to implementing QMS in compliance with ISO 9001:2000 requirements. In addition, the research will evaluate the current product realization process and redesign it to contain quality monitoring in almost all phases.

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[1] Quality Management System will be referred as QMS in the entire study

By concentrating on the software production processes only, the study shows the benefits of updating the old production operations to a new one that assure better quality and management of all company's resources.

Adopting this project or not is the management decision. This decision will be definitely influenced by the benefits that SecurSoftware can get from the ISO 9001:2000, the budget and the project's return on investment (ROI).

1.2 Need for the study

As mentioned in the previous section, SecurSoftware is facing troubles concerning its operations and sales. Some issues are directly related to the company itself and some others are caused by the external environment. These issues trigger the company to think about changing its current management system into a one that guarantees continuity and growth. The list below shows briefly the problems faced within the company. Section 3 in chapter 2 explains each one of them in detail:

- 'ad-hoc' code becoming production code
- Absence of code documentation
- Lack of communication among team members
- Ignorance of the importance of test engineers job
- Delays in almost every release because of incomplete software
- Big numbers of bugs in the final releases
- Lack of discipline among all production processes.

The external factors encouraging and obliging the company to change its management strategy are listed below:

- Customer disappointment from the software due to continual releases of patches solving bugs found after the software is sold
- Customer request ISO registration to keep buying company's products or start doing business with the company
- Availability of cheap software in the market that is leading companies to add value to their software by promoting it as ISO verified product
- Quality becoming the first attribute that customer looks for when buying software

1.3 Purpose of the Study

One of the two main purposes of this study is to reveal the benefits companies can generally get with the implementation of a quality management system complying with international standards that are already known and used worldwide such as ISO 9001:2000. The second purpose is to show the importance of quality when producing software goods. These two purposes are linked to each other knowing that companies can apply QMS to get quality product.

Benefits of implementing ISO 9001:2000

The points listed in this paragraph, explain briefly the main advantages, any company can get when implementing a quality management system in compliance with ISO 9001:2000:

- International standards are important in international trade because unequal standards can be barriers to trade. They give some organizations advantages in certain areas of the world and provide clear identifiable references recognized internationally as well as encourage fair competition in free-market economies.
- Facilitate trade through enhanced product quality and reliability, greater ease of maintenance and reduced costs.
- Retain and increase market share, sales and revenues by promoting quality product.
- Allow access to new markets: some markets require ISO 9001 Registration, some markets favour companies with ISO 9001 Registration
- Control business functions required to operate in a disciplined way: almost no matter what happens, the company has a systematic way of responding
- Help employees to see in a clearer way what to do, and how to do the job. Thus, they don't spend time 'making things up' or duplicating efforts.
- Allow the management to catch the error more quickly
- Allow better management control and reporting
- Encourage continual improvement

Importance of monitoring quality in Software production

This paragraph summarizes the main advantages the company can get from monitoring quality earlier in the software development process:

- Better internal operational efficiency.
- Constant quality measurement and thus earlier detection of deficiencies along with corrective actions at lower prices.
- Lower production costs because of fewer nonconforming products, less rework, lowered defect rates, streamlined processes and fewer mistakes.
- Corrective action for all defects.
- Easier documented procedures for new employees to follow.

1.4 Overview of all chapters

Chapter II gives an overview about ISO, its emergence and its eight quality management principles. In addition, it explains the process approach, the subject that the revised ISO 9001:2000 stressed on. Some definitions related to the software development environment are also to be mentioned. The second part of chapter II summarizes seven articles relevant to the study done in this research. The last part of the chapter introduces the software company the research is working on.

Chapter III presents a simple step-by-step process for the top management to follow in applying a quality management system in compliance with ISO. The second part of chapter III explains briefly the clauses of ISO and presents the result of a gap analysis conducted in the company.

Chapter IV identifies new interrelated processes flowchart for the company to adopt, and designs new processes to follow in compliance with ISO 9001:2000.

A timescale and budget estimates for the ISO implementation project are given in the last section of the chapter.

Chapter V lists the limitation of the study as well as the factors that may affect the implementation plan. It concludes the research by giving the company top management recommendations concerning the post and pre ISO implementation phase.

Chapter 2

Review of Literature

The sections' subjects written under "theories related to the topics" were selected in a way to be used as a secondary data helping to set a complete study of the QMS implementation project to the Lebanese software company "SecurSoftware". Defining ISO and giving an overview of its development is a must to be able to understand the concepts of standards. Talking about the revised standard ISO 9001:2000 together with its 8 principles introduces the readers as well as SecurSoftware top management to such standards' targets. It also reveals the importance of getting certification from ISO and the benefits, on the long and short term. Knowing that ISO 9001:2000 is a process-oriented standard, and SecurSoftware operational structure needs to be reorganized into processes, the research developed a section clearly defining what is a process, how processes are interrelated and what are the major processes that set a complete QMS in any company. In addition, giving that SecurSoftware is a software company, explaining the main tasks of the software development operation adds value to the study.

2.1 Theories Related to the Topic

2.1.1 ISO History Overview

ISO is a network of the national standards institutes of 157 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. The countries are divided into three categories: the member bodies, the correspondent bodies and the subscriber bodies.

A *member body* of ISO is the national body "most representative of standardization in its country". Only one such body for each country is accepted for membership of ISO. Member bodies are entitled to participate and exercise full voting rights on any technical committee and policy committee of ISO

A *correspondent member* is usually an organization in a country, which does not yet have a fully developed national standards activity.

Correspondent members do not take an active part in the technical and policy development work, but are entitled to be kept completely informed about the work of interest to them

Subscriber membership has been established for countries with very small economies. Subscriber members pay reduced membership fees that nevertheless allow them to maintain contact with international standardization

ISO is a non-governmental organization: its members are not delegations of national governments, as it is the case in the United Nations system. Nevertheless, ISO occupies a special position between the public and private sectors. This is because, many of its member institutes are part of their countries' governmental structure or mandated by their government on one hand, and other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations on the other hand.
Therefore, ISO is able to act as a bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users.[2]

The Lebanese Standards Institution (LIBNOR) was established in 1962 as a public organization having sole authority for issuing national standards, granting the Conformity Mark to Lebanese Standards, and representing Lebanon internationally in standardization activities. It ceased its operations and lost its membership in ISO during the 1980s, due to the civil war in Lebanon and the devaluation of the Lebanese currency, among other reasons.
LIBNOR has been under rehabilitation since 1994 to take an active role in developing national standards. It has established some standards for the construction industry: material, equipment and methods- for the agro-food industry, light chemical industry, petroleum industry, electrotechnical industry, and the textile and leather industry.[3]

ISO Name

Because "International Organization for Standardization" would have different abbreviations in different languages, it was decided at the outset to use a word

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2 www.iso.org/

3 www.libnor.org/

derived from the Greek isos, meaning "equal". Therefore, whatever the country, whatever the language, the short form of the organization's name is always ISO.[4]

ISO History

International standardization began in the electrotechnical field: the International Electrotechnical Commission (IEC) was established in 1906. The International Federation of the National Standardizing Associations (ISA), which was set up in 1926, carried out pioneering work, in other fields. The emphasis within ISA was laid heavily on mechanical engineering. ISA's activities came to an end in 1942.
In 1946, delegates from 25 countries met in London and decided to create a new international organization, of which the object would be "to facilitate the international coordination and unification of industrial standards". The new organization, ISO, officially began operations on 23 February 1947.

The 2700 technical committees, subcommittees and working groups, do the bulk of the work of ISO. Each committee and subcommittee is headed by a Secretariat from one of the member organizations.
ISO covers a wide variety of standards with the exception of electrical and electronic engineering standards covered by the International Electrotechnical Commission (IEC), telecommunication standards covered by the International Telegraph Union (ITU) and information technology covered by JTC 1 (a joint committee between ISO and IEC). [5]

2.1.2 The Revised ISO 9000 standard

ISO Technical Committee published the ISO 9000 standards for quality assurance and quality management in 1987. This series of standards had a dramatic impact due to their scope and rate of acceptance. It applies to all sizes and types of manufacturing and service companies and covers almost everything in a company's business functions with the main focus on processes, procedures and practices. Whether large or small, ISO 9000 standards have been widely accepted in nearly every developed country.

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4 http://en.wikipedia.org/wiki/International_Organization_for_Standardization

5 http://www.sis.pitt.edu/~mbsclass/standards/martincic/iso9000.htm

As Hall states; "*the focus was to do things right in the first place rather than the retrospective, and more expensive, doctrine of inspection for faults after the event*".[6]

ISO "9000" currently includes three quality standards: ISO 9000:2005, ISO 9001:2000, and ISO 9004:2000. ISO 9001:2000 presents ***requirements***, while ISO 9000:2005 and ISO 9004:2000 present ***guidelines.*** (For the detailed history of ISO 9000 family, refer to appendix A).

A company that has undergone ISO 9000 certification basically guarantees that they are true to their word. This gives customers and clients a sense of satisfaction and peace of mind.[7] These standards do not reflect the quality of goods or service, but rather refer to the manner in which a company ensures its quality level.

The main value of the 9000 series is that the analysis of processes required by the standard leads to improving or re-engineering of processes. The benefits to a company who follows the standard's practices are said to be new markets for their goods and services, increased cost-efficiency, improved employee morale and increased customer satisfaction.

The quality concepts addressed by these standards are:

- An organization should achieve and sustain the quality of the product or service produced so as to meet continually the purchaser's stated or implied needs.
- An organization should provide confidence to its own management that the intended quality is being achieved and sustained.
- An organization should provide confidence to the purchaser that the intended quality is being, or will be, achieved in the delivered product or service provided.

The ISO 9001:2000 quality management system is a 'process model' with the integration of five major clauses: Quality Management System (4), Management Responsibility (5), Resource Management (6), Product Realization (7) and Measurement Analysis and Improvement (8) as shown in the figure below (figure 1). The first part of chapter three will discuss in details the major clauses of ISO 9001:2000.

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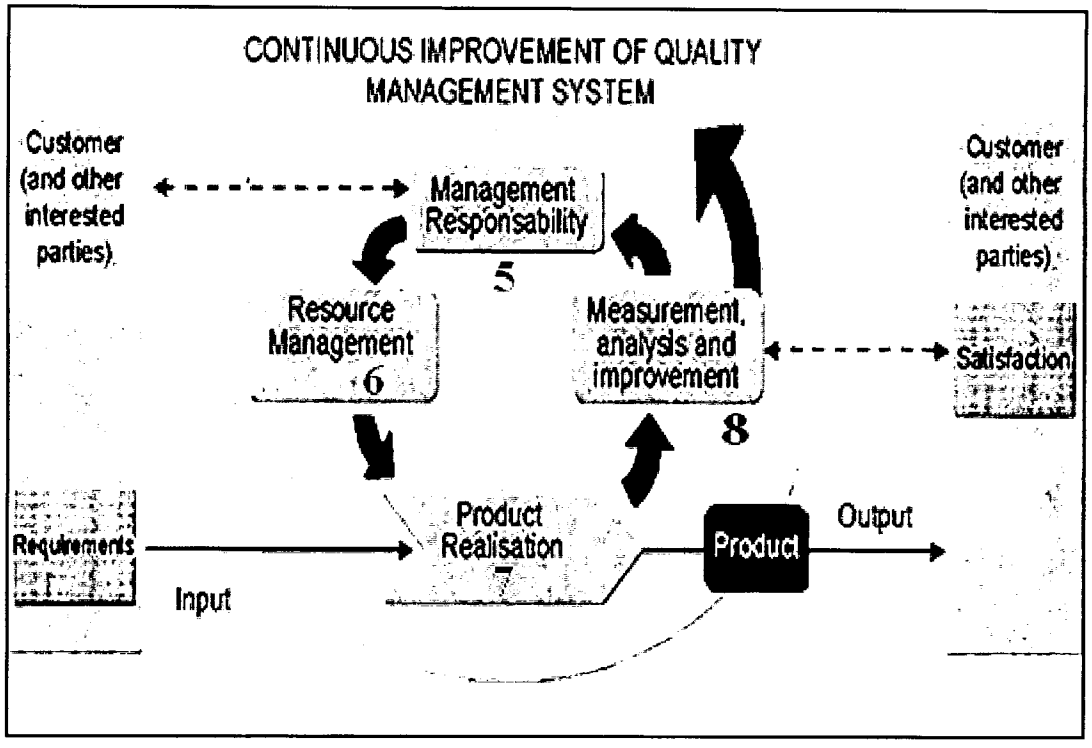
[6] Hall, T. J. The Quality Systems Manual: the definitive guide to the ISO 9000 family and TickIt. John Wiley and Sons: Chicester, England.1995

[7] http://www.iso9000-web.com/

Furthermore, this model incorporates the eight quality principles of *Leadership, Customer Focus, Process Approach, Supplier Relationships, Factual Approach, Systems Approach, Involvement of people and Factual approach to decision making.* These principals are discussed in the next section entitled "ISO 9000:2000 Quality Management Principles".

Figure 1: Interactions in ISO Processes



Source: www.estc.gov.et, doc: QMS development and implementation based on ISO: 9001:2000

2.1.3 ISO 9000:2000 Quality Management Principles

The ISO technical committee working on the ISO 9000 standards had published a document detailing the quality management principles and application guidelines. The latest revision (version 2000) of ISO 9000 standards are based on these principles: Customer focus, leadership, involvement of people, process approach, system approach to management, continual improvement, factual approach to decision making and mutual beneficial supplier relationships. ISO chose these principles because they can be used to improve organizational performance and achieve success. Following is a detailed explanation of how to apply the principles in any organization.

Definition of Quality Management Principle

"A quality management principle is a comprehensive and fundamental rule or belief, for leading and operating an organisation, aimed at continually improving performance over the long term by focusing on customers while addressing the needs of all other stake holders".[8]

Principle 1: Customer Focus

Organizations rely on customers. Therefore, they must understand customer needs and requirements and strive to exceed customer expectations.

Steps in application of this principle are:

1. Understand customer needs and expectations for products, delivery, price, and dependability.
2. Ensure a balanced approach among customers and other stakeholders (owners, people, suppliers, local communities and society at large) needs and expectations.
3. Communicate these needs and expectations throughout the organisation.
4. Measure customer satisfaction and act on results.
5. Manage customer relationships.

Principle 2: Leadership

Organizations rely on leaders. Therefore, leaders must establish a unity of purpose and set the direction that the organization should take. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.

Steps in application of this principle are:

1. Be proactive and lead by example.
2. Understand and respond to changes in the external environment.
3. Consider the needs of all stake holders including customers, owners, people, suppliers, local communities and society at large.
4. Establish a clear vision of the organisation's future.
5. Establish shared values and ethical role models at all levels of the organisation.

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[8] The definition is extracted from the official document numbered ISO/TC 176/SC 2/WG 15/N131

6. Build trust and eliminate fear.
7. Provide people with the required resources and freedom to act with responsibility and accountability.
8. Inspire, encourage and recognise people's contributions.
9. Promote open and honest communication.
10. Educate, train and coach people.
11. Set challenging goals and targets
12. Implement a strategy to achieve these goals and targets.

Principle 3: Involvement of People

Organizations rely on people. People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.

Steps in application of this principle are:

1. Accept ownership and responsibility to solve problems.
2. Actively seek opportunities to make improvements, and enhance competencies, knowledge and experience.
3. Freely share knowledge & experience in teams.
4. Focus on the creation of value for customers.
5. Be innovative in furthering the organisation's objectives.
6. Improve the way of representing the organisation to customers, local communities and society at large.
7. Help people derive satisfaction from their work and make them proud to be part of the organisation.

Principle 4: Process Approach

A "Process" can be defined as a "Set of interrelated or interacting activities, which transforms inputs into outputs"

Organizations are more efficient and effective when they use a process approach, to manage activities and related resources.

Steps in application of this principle are:

1. Define the process to achieve the desired result.
2. Identify and measure the inputs and outputs of the process.
3. Identify the interfaces of the process with the functions of the organisation.

4. Evaluate possible risks, consequences and impacts of processes on customers, suppliers and other stakeholders of the process.
5. Establish clear responsibility, authority and accountability for managing the process.
6. Identify internal and external customers, suppliers and other stake holders of the process
7. When designing processes, consider process steps, activities, flows, control measures, training needs, equipment, methods, information, materials and other resources to achieve the desired result.

Principle 5: System Approach to Management

Identifying, understanding and managing interrelated processes as a system, contributes to the organization's effectiveness and efficiency in achieving its objectives. Therefore, the organization must identify interrelated processes and treat them as a system.

Steps in application of this principle are:

1. Define the system by identifying or developing the processes that affect a given objective.
2. Structure the system to achieve the objective in the most efficient way.
3. Understand the interdependencies among the processes of the system.
4. Continually improve the system through measurement and evaluation
5. Estimate the resource requirements and establish resource constraints prior to action.

Principle 6: Continual Improvement

Organizations must make a permanent commitment to continually improve their overall performance.

Steps in application of this principle are:

1. Make continual improvement of products, processes and systems an objective for every individual in the organisation.
2. Apply the basic improvement concepts of incremental improvement and breakthrough improvement.
3. Use periodic assessments against established criteria of excellence to identify areas for potential improvement.

4. Continually improve the efficiency and effectiveness of all processes.
5. Promote prevention-based activities.
6. Provide every member of the organisation with appropriate education and training, on the methods and tools of continual improvement such as the Plan-Do-Check-Act cycle, problem solving, process re-engineering, and process innovation.
7. Establish measures and goals to guide and track improvements
8. Recognise improvements.

Principle 7: Factual approach to decision making

Organizations perform better when their decisions are based on facts. Therefore, they must base decisions on the analysis of factual information and data.

Steps in application of this principle are:

1. Take measurements and collect data and information relevant to the objective.
2. Ensure that the data and information are sufficiently accurate, reliable and accessible.
3. Analyse the data and information using valid methods.
4. Understand the value of appropriate statistical techniques.
5. Make decisions and take action based on the results of logical analysis balanced with experience and intuition.

Principle 8: Mutual beneficial Supplier Relationships

Organizations depend on their suppliers to help them create value. Therefore, they must maintain a mutually beneficial relationship with their suppliers

Steps in application of this principle are:

1. Identify and select key suppliers.
2. Establish supplier relationships that balance short-term gains with long-term considerations for the organisation and society at large.
3. Create clear and open communications.
4. Initiate joint development and improvement of products and processes.
5. Jointly establish a clear understanding of customers' needs.
6. Share information and future plans, and
7. Recognise supplier improvements and achievements.

Relationship to Organizational Development

As one can see from the eight principles, ISO 9000 is not about specific quality control or assurance techniques. It is about creating an organization, which is customer centered and where employees are given the right and the power to accomplish that goal. Any organization seeking survival must practice the principles promulgated in the ISO 9000 standards, whether they seek certification or not.

In order to adhere to these practices, one must create or recreate the organization, using leadership and participation to embed customer focused processes into the design and delivery of products and / or services.

2.1.4 Process Approach

The *process approach* is a management strategy. When managers use a process approach, it means that they manage the processes that make up their organization, the interaction between these processes, and the inputs and outputs that glue these processes together.

Definition of process

Any activity or operation that receives inputs and converts them to outputs can be considered as a process. Often, the output from one process will directly form the input into the next process[9]. Almost all activities and operations involved in making a product or providing a service are processes. A schematic representation of a process is drawn in figure 2.

ISO 9001:2000 stresses the importance for an organization to identify, implement, and manage interlinked processes as well as to continually improve the effectiveness of the processes that are necessary for the quality management system and for achieving the company's objectives.

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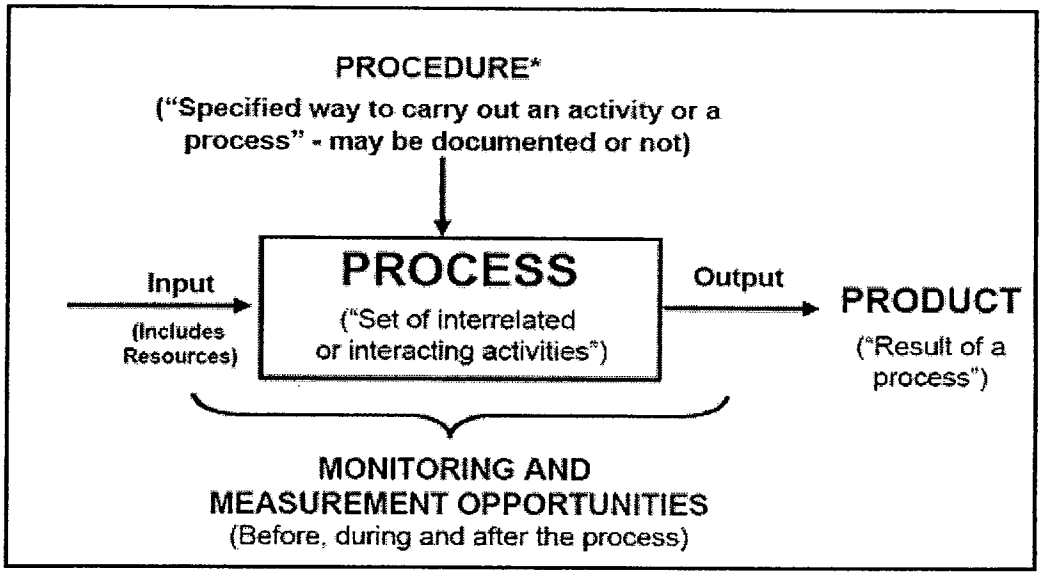
[9] Tricker, Ray and Sherring-Lucas, Bruce. 2005. ISO 9001:2000 in brief. Amsterdam: Elsevier/Butterworth-heinemann. (p 31 section 2.6.1)

Figure 2: Schematic Representation of a Process



Source: www.iso.org, doc: iso/TC 176/SC 2/N 544R

The P-D-C-A Cycle and the Process Approach

The quality management system structure is now viewed as a series of processes. The process-based structure is based on the "Plan-Do-Check-Act" improvement cycle (see figure 3).

The "Plan-Do-Check-Act" cycle was first developed in the 1920's by Walter Shewhart, and popularized later by W. Edwards Deming. For that reason it is often referred to as "The Deming Cycle". Within the context of a quality management system, the PDCA is a dynamic cycle that can be deployed within each of the organization's processes, and to the system of processes as a whole. It is intimately associated with the planning, implementation, control and continual improvement of both product realization and other quality management system processes.

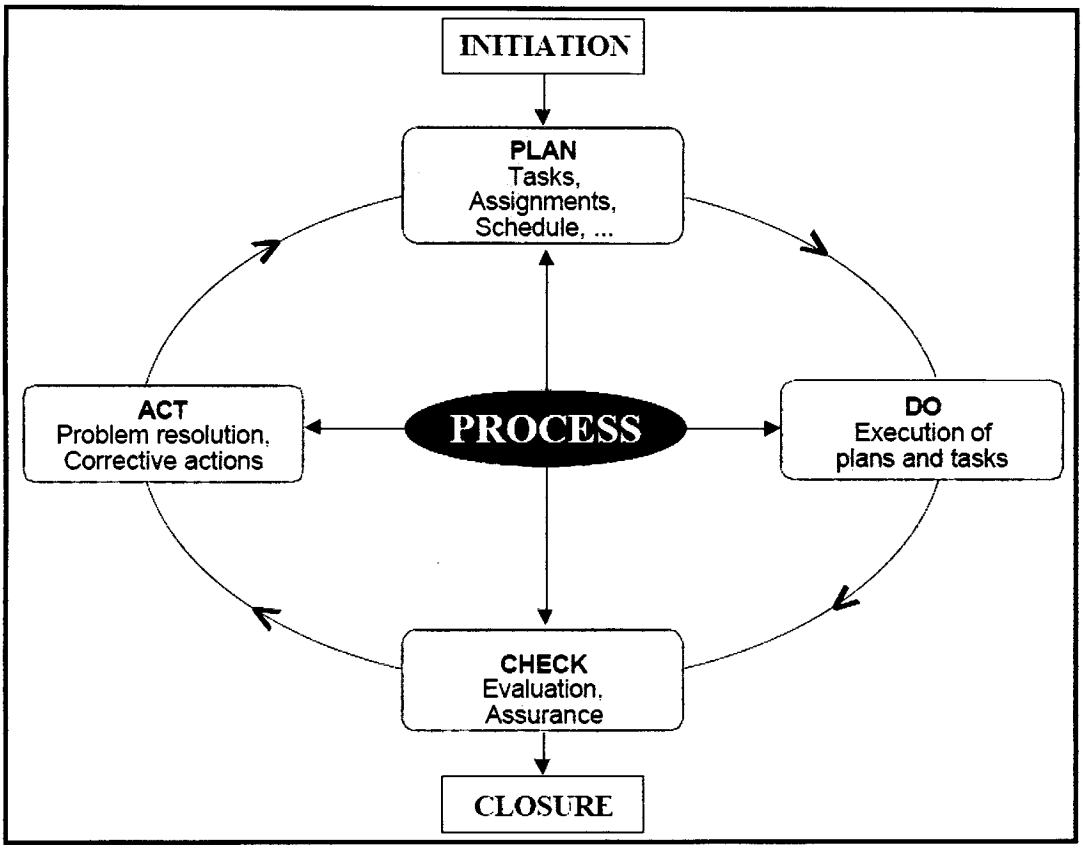
Maintaining and continually improving the process capability can be achieved by applying the PDCA concept at all levels within the organization. This applies equally to high-level strategic processes, such as quality management system planning, or management review, and to simple operational activities carried out as a part of product realization process

ISO 9001:2000 explains that the PDCA cycle applies to processes as follows:

- Plan: establish the objectives and processes necessary to deliver results in accordance with customer requirements and the organization's policies
- Do: implement the processes;

- Check: monitor and measure processes and product against policies, objectives and requirements for the product and report the results;
- Act: take actions to continually improve process performance

Figure 3: Process Partitioned into PDCA Activities

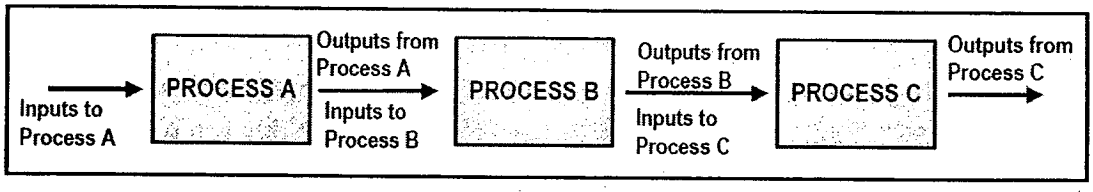


Source: www.abelia.com, doc: an introduction to international standards ISO/IEC 12207, software life cycle processes

For organizations to function, they have to define and manage numerous inter-linked processes. Often the output from one process will directly form the input into the next process as shown in figure 4. The systematic identification and management of the various processes employed within an organization, and particularly the interactions between such processes, may be referred to as the 'process approach' to management. The revised quality management system standards are based on just such a process approach, in line with the guiding quality management principles.[10]

[10] www.iso.org

Figure 4: Example of a Generic Process Sequence



Source: www.iso.org, doc: ISO/TC 176/SC 2/N 544R2(r)

Since the process approach is now central to ISO's approach, the following processes make up a complete ISO 9001 2000 Quality Management System. As the following list shows, there are 22 processes:

1. Quality Management Process
2. Resource Management Process
3. Regulatory Research Process
4. Market Research Process
5. Product Design Process
6. Purchasing Process
7. Production Process
8. Service Provision Process
9. Product Protection Process
10. Customer Needs Assessment
11. Customer Communications Process
12. Internal Communications Process
13. Document Control Process
14. Record Keeping Process
15. Planning Process
16. Training Process
17. Internal Audit Process
18. Management Review Process
19. Monitoring and Measuring Process
20. Nonconformance Management Process
21. Continual Improvement Process
22. General Systematic process

The ISO process is designed so that you "say what you are going to do" and then you "do what you said". The research will use this process list in identifying and dividing SecurSoftware processes. Chapter four will explain in details, each process and its contribution to the success of the quality management system being implemented.

2.1.5 Software Development Life Cycle [11]

A software development life cycle is a structure imposed on the development of a software product. This structure is divided into several main tasks. Each task is described below as to get familiar with the business terminology. This paragraph helps you understand the different processes presented in chapter 4 of this research.

1. Domain Analysis

It is the first step to design new software or a piece added to a software application. This step analyzes related software systems in a domain to find their common and variable parts. The more developers and analysts are aware about the domain, the less the work is required. Another objective of this step is to make the analysts speak in the domain's own terminology with professionals and experts so that they better understand what is being said by these people.

2. Software Requirements Analysis

The most important task in creating a software product is extracting the requirements. Customers typically know what they want, but not what the software should do and can do. Frequently demonstrating live code may help reduce the risk of having incorrect requirements.

3. Specification:

Writing the specification will help the user understand what the software will do. Usually, specifications are written in a rigorous way.

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[11] Pressman, Roger S. 2005. Software engineering: a practitioner's approach. Boston, Mass. : McGraw-Hill. p 20-21

4. Software architecture:

The architecture of a software system refers to an abstract representation of that system. Architecture is concerned with making sure the software system meets the requirements of the product, as well as ensuring that future requirements can be added.

5. Coding:

Reducing a design to code may be the most obvious part of the software engineering job, but it is not necessarily the largest portion.

6. Testing:

Software testing is the process used to measure the quality of developed software. Once the code has been generated, program testing begins. It focuses on the logical internals of the software. Usually, quality is constrained to such topics as correctness, completeness, security, but it includes more technical requirements as described under the ISO standard, such as capability, reliability, efficiency, portability, maintainability, compatibility, and usability.

7. Implementation:

After the code is appropriately tested and approved, it is moved into production environment i.e. is made available for business use.

8. Documentation:

An important (and often overlooked) task is documenting the internal design of software for the purpose of future maintenance and enhancement.

9. Software Training and Support:

Organizing training classes for software users and/or writing users manual to help customers understand the software.

10. Maintenance:

Maintaining and enhancing software to cope with newly discovered problems or new requirements can take far more time than the initial development of the software. About ⅔ of all software engineering work is maintenance. A small part of

that is fixing bugs. Most maintenance is extending systems to do new things, which in many ways can be considered new work.

2.2 Previous Research

This section deals with current articles that have been written on different issues related to ISO 9001:2000. Each article has been selected based on its contents whether it adds new info to the study or it gives hints about how to introduce a QMS to SecurSoftware Company (discussed in chapter 4). Every article will be summarized into the essence of its findings and its relevance and contribution to the research. Questions answered by some articles are mainly the following:

What is the Process implementation in software industry? Will ISO 9001 improve the financial performance of the firm? Will ISO 9001 certify the quality of the products and services? Why should we get ISO 9001 certified?

2.2.1 How can ISO 9000:2000 help companies achieve excellence? By L. Boulter and T. Bendell

(Taking from the Measuring Business Excellence journal, 6,2 2002 ,p.p 37-41)

Even though, there is a limited literature pertaining to quality in small firm context, Louise Boulter and Tony Bendell have conducted a project with the collaboration of the University of Leicester dealing with the impact of the revised ISO 9000 which is ISO 9001 on small firms.

The project led to the following conclusion: "positive support for the view that ISO 9000 can help pursuit of excellence. There is a link to continuous improvement, to more involvement of top management and higher priority on resource considerations with the new standard; and this should lead more towards excellence. ISO 9000 was by far the most important business initiative for small firms.

This research is valuable knowing that SecurSoftware starts selling for outside Lebanon markets and needs to promote better its products.

2.2.2 ISO 9000- A Managerial Approach, by Carl Gustav Johannsen

(Taken from Library Management journal, Vol 17 · N 5, 1996· p.p · 14–24)

The article is divided into three parts. The third part, which I will treat, is directly related to my topic knowing that it explains a successful way to implement

a quality management system as ISO 9000. The implementation model has 7 stages. It starts with the definition of ISO project scope, the analysis of processes, the choice of a focus, the selection of standards and requirements, to the design and making of the quality manual till the drawing of the process. Each stage is explained in details, which is very valuable to SecurSoftware knowing that the company has no quality system implemented yet and needs a detailed model showing the implementation from the very beginning.

2.2.3 ISO 9000 – what it means to international business today by T. Masternak and B.H. Kleiner

(Taken from Training for Quality journal, Vol 3, N 4, 1995 · p15–18)

The article explores the real reason why ISO has become a market force hence its importance to today business. It talks about International exchange of goods and services, about customer-driven prerequisite for supplying goods to many businesses, and about quality improvement processes. Beside, the ISO is an investment in money and time therefore it requires a commitment from all top management in order to succeed. Reasons described in this article correspond to what is happening in SecurSoftware considering their main new markets in Dubai and Saudi Arabia.

2.2.4 ISO 9001 standard and software quality improvement by V. Jovanovic and D Shoemaker

(Taken from Benchmarking for Quality Management & Technology journal, Vol. 4 No. 2, 1997, p148-159)

The aim of this study is to introduce the ISO 9000 series of requirements as they apply to business oriented software development and maintenance. The goal is to establish efficient processes in compliance with ISO 9001, ISO 9000-3 and the accepted practices of a company and of the software industry. The study also demonstrates that the transition from the ISO 9001 standard into a practical realm of business software improvements is not too difficult to start with.

Each part included in the quality system program is explained in detail. The research is showing very useful to my study knowing that I am introducing a quality system program to a company operating in the software industry.

2.2.5 The impact of the ISO standards in small software firms by Rodney Macadam and Frances Fulton

(Taken from Managing Service Quality journal, vol 12, N 5, 2002, p336-345)

The revised ISO 9000 is explored in this study with the following research questions:

1. What is the current state of quality-management practices in the software industry?
2. How is the revised ISO 9000:2000 series of standards perceived within the software industry?

The surveys conducted showed many statistics, the following are the most important to the study:

1. The quality management system has impact on business: the majority voted for "improved company image" then come "increased customer satisfaction", then "increased productivity, and market share"
2. The majority of the respondents has a quality management system (the majority of them has ISO)

Knowing that the majority of the software firms are searching for improving their process, introducing a quality system that reshapes the software development process at SecurSoftware is a good start for going global.

2.2.6 A system model for ISO 9000 standards by Chong-Chuan Lim

(Taken from Managing Service Quality journal, Vol 8, N 1, 1998, p64-67)

In this article, a system model for ISO 9000 series of standards is proposed. It is based on the principles of system thinking. The author points out in the paper two system cycles that should be practiced to make the system model visible: a system cycle on structure consisting of three stages; and a system cycle on processes in links and loops across the structure. The system cycle on structure represents a long term performance management system, whereas the system cycle on processes in links and loops represents a short-term performance management system. What is valuable in this article for the study is the model proposed by the author showing 2 different portions. These portions have different blocks and processes. This structure will be used in study of the implementation of a quality system in SecurSoftware Company.

2.2.7 An Empirical Analysis of Productivity and Quality in Software Products by M. S. Krishnan C. H. Kriebel

(Taken form Management Science journal, Vol 46, No. 6, June 2000 pp. 745-759)

The article examines the relationship between life-cycle productivity and quality in software products. The effects of product size, personnel capability, software process, usage of tools, conformance quality are analyzed to derive managerial implications based on primary data collected on commercial software projects. The findings are as follows:

First, the results provide evidence for significant increase in life-cycle productivity from improved conformance quality in software products shipped to the customers.

Second, the study identifies several quality drivers in software products. The findings indicate that higher personnel capability, deployment of resources in initial stages of product development (especially design) and improvements in software development process factors are associated with higher quality products.

To achieve such quality product, a quality system management must be implemented. The article gives another push to implement ISO 9001:2000 which is a complete system that re-organizes the company's processes knowing that the latter company needs to add value to its products by improving the quality.

2.3 SecurSoftware

2.3.1 General Overview on SecurSoftware

SecurSoftware is a medium size company with about 37 employees. The company is a provider for Enterprise and Personal information security solutions. SecurSoftware specializes in the design and development of strong data security applications through user authentication and password management solutions, data encryption and data shredding facilities. SecurSoftware also offers application monitoring services and web reporting to enhance the overall security system of an organization.

SecurSoftware Value

The corporate values and basic principles are:

- Individual approach to every new project to better understands what is critical to the clients' success and how this particular project fits into their overall business strategy.
- Premium Customer Service
- Cutting-edge technologies and high performance

SecurSoftware Vision

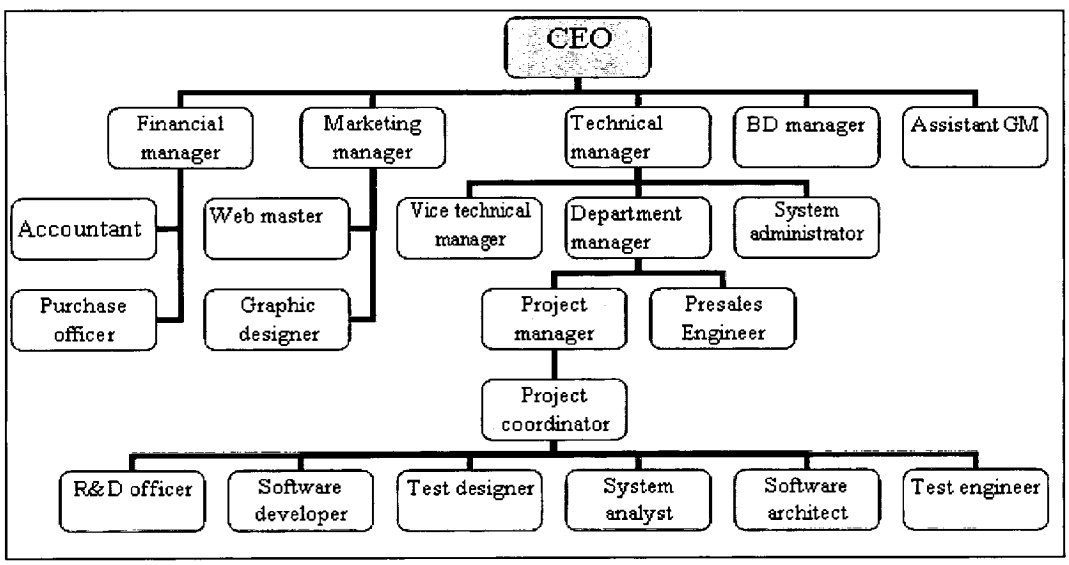
SecurSoftware is committed to become a global software development Factory Competing with big enterprises and serving customers in a high professional manner. Customers are better informed and their expectations are growing. The company is focusing its marketing and sales efforts, on maximizing its market share in the developed European countries and in the USA; this matter requires:

- A high quality coding system, and Software Production
- An excellent workflow process.

The main focus would be:

- Quality assurance,
- Fast delivery,
- Excellent Customer support.

Figure 5: SecurSoftware Functional Flowchart



Source: SecurSoftware Official Documents

2.3.2 Need for ISO 9001:2000 Certification

Competition has always been the driving force behind any market economy. It fuels innovation and stimulates the marketplace. This fact has not changed, nor will it change. What has changed, however, is the way in which businesses compete against one another. In the software industry, making software that works is not important anymore; what really matters is Quality. Quality can make or break a company. So, to get quality software one should begin to follow standard rules and norms.

As the project manager of SecurSoftware states:" What our company really needs is to reorganize itself to be able to increase its profits. We have all needed resources to be able to compete on an international level. We have entered the European market 5 years ago; we have our customers and our connections there. But now, we noticed a decrease in our annual market share. Moreover, we are working on projects in the Middle East more precisely in Saudi Arabia and Dubai. We sent a professional team there. These markets are niche markets for our products. However, the problem that is always showing is failing to complete the projects on time and within budget mainly because of the bugs that always shows in the advanced phases.

In our beginnings, everything was going great. But the big error that was done is when the company jumped from 15 employees to 45 (4 years ago); it did so without any update in the system processes. We, as the management, are very aware that the first solution is reshaping all our processes. And these processes should be based on international standards. ISO can be our solution".

After brainstorming about the main issues the company was facing, the research has come up with the below listed point:

'ad-hoc' code becoming production code

The ad-hoc code is the code that is made just for making the software working now. This is usually under the pressure of deadline looming. But the problem in SecurSoftware is that this kind of code is becoming common during regular development cycle because no code norms are defined, no code documentations are required and no serious testing is done during the first phases of the software development. The tragedy is that the ad-hoc code is ending up in the candidate release and is causing lots of bugs which are very costly to fix, a slow performance

which cannot be fixed unless the work is redone and finally a very hard time for developers who are maintaining the software.

Absence of code documentation

SecurSoftware technical manager assigns documentation to be lower priority than actual coding, but most developers incorrectly interpret this as optional work. What missing in the current software processes is the written documentations for the developers to follow. In reality, the main standard documents which are the business development plan (BDP), the software architecture and testing plan are written after the software is finished or at least in its late betas version. This chaos is the result of the lack of auditing and is leading to bad results like:

- Software not adequate with the initial specifications
- Impossibility for a new developer to join the team in the mid phases
- Impossibility to benefit from previous code functions in new software projects

Lack of communication between team members

In most projects only the project manger knows the overall project specs and design. Most other developers are only concerned with their own module. This is causing problems in the integrating phase when some modules are not compatible with others. Making all developers familiar with more parts of the system will definitely help in overall project quality. This way, all developers will be able to provide guidance and predict the impact of changes on different parts of the system.

Ignorance of the importance of test engineers job

As the quality department manager states:" Developers don't understand that our job is complimentary to their job. They even don't know the advantages of testing the application in each single process from the inception phase till the integration one. What they need is a training session that explains the real job of the test engineers and how to deal maturely with them".

Currently, the test checking on the software functionality is missing in all processes except the last one; the validation process. This is making a hard time for tester to find all bugs and for developers to fix those bugs before getting to the due date. The solution is to update all processes by including the test planning in the very early phases; ideally at the same time as the team starts working on the

specification. Chapter four explains in details how quality checking can be integrated in the processes so that the latter can fit the standards requirements.

As a summary, SecurSoftware has the vision, the strategy, the talented people and the financial strength to grow. Their access in the last 2 years to external wide markets, as Dubai and Saudi Arabia, give them a push to work harder. Competition in those markets is mainly competition for quality rather than for options in the software sold. SecurSoftware Holding must reshape all its software development processes to be able to compete on international level. Seeking ISO certification is the best solution to start with because it is widely acknowledged that proper quality management improves business. Implementing ISO gives the following benefits:

- Create a more efficient, effective operation.
- Increase customer satisfaction and retention.
- Enhance marketing.
- Improve employee motivation, awareness, and morale.
- Promote international trade.
- Increases profit.
- Reduce waste and increases productivity.

The result of the research showed that the implementation of ISO 9000 affects the entire organization right from the start. If pursued with total dedication, it results in 'cultural transition' to an atmosphere of continuous improvement.
The research subjects clarified the concepts of standards and quality; plus verified the need of the dedication that the top management and the employees should feel in order to improve the company as a whole.

If a general outline should be written about the benefits that the literature review is giving to the research, the list must begin with the process approach.
SecurSoftware, as mentioned in chapter one, is facing problems concerning its management of software production operations. Knowing that the process approach is an efficient management strategy, the study will apply the "Plan-do-check-act" cycle theory explained in 2.1.4, on the new processes in SecurSoftware

technical department. With the PDCA cycle, the new system will be able to optimize the output of its processes as well as their capabilities.

The literature review mentioned also how to interrelate processes where output of one process will be the input of the next process. This sequence will be applied in the product realization operation in the 3 consecutive new processes (inception, construction and validation). Chapter 4 will draw the related flowchart so that the sequence can be clearly noticed.

In addition, recommendations to SecurSoftware top management listed in chapter 5 are based on the eight quality management principles explained in 2.1.3 section. Any company seeking survival must apply those principles in its entire structure.

The articles contents summarized in section 2.2 were mainly used in the QMS implementation project. The second, forth and sixth articles explain in details the different stages of the implementation and the ISO 9001:2000 series of requirements applying to a software development business. Chapter 4 will utilize this information to set a customized plan adequate to SecurSoftware structure. As for the first and fifth articles listed in the Previous Research section of this paper, they will be used as arguments to prove for SecurSoftware management the positive impact ISO has on its business as a whole. The seventh article emphasized on quality- its importance concerning the system productivity. The data contained in this article will be used in designing the processes of the company technical department. The quality drivers identified in the article will be integrated in the processes like the deployment of resources in the initial stages of software production. Chapter 4 shows how quality checking is integrated in the production and its effects on productivity.

The implementation of a QMS needs a detailed study starting from the current condition of the company, moving to the analysis of the requirements, then the design of all processes, ending by relating all processes to form an efficient system. Chapter three presents the main clauses of ISO 9001:2000 and then shows the gap between these clauses and the current SecurSoftware situation. In addition, the study states how and what data to be collected as well as the way ISO will be introduced to the management.

Chapter 3

Procedures and Methodology

Making the decision to become registered to ISO9001: 2000, is a very simple one, as the benefits are very well documented in every article we read.

A more difficult task is putting the documentation together and successfully completing an implementation plan. There is no single proposal for implementing ISO 9001: 2000. Every plan is as unique as the company, which implements it. However, this study gathered different plans and made a plan that corresponds to SecurSoftware regarding staff and size. The plan is described in the section that follows and can prepare the company for a successful quality program.

Relevant data was collected by the interview done with the CEO which focused on the willingness and enthusiasm towards implementing a QMS as well as, putting enough budgets for such program. Data were also collected by another interview done with the technical manager regarding the technical problems faced that could stand as barrier to such a system or could decrease from its efficiency.

3.1 Introducing ISO to SecurSoftware

One of the top management interview conclusions is a need for a plan to clarify the steps for the implementation of a quality program. Consequently, the restructuring of the firm's processes are clear right from the beginning. But before writing the action plan, a management representative[12] (MR) should be selected to act as quality management system champion. This person must have the following credits:

- A total backing from the CEO
- A passionate commitment to quality
- The dignity to influence managers and others of all levels and functions

Step 1: Top Management Commitment.

A clear understanding of the ISO 9001:2000 requirements is a must. Knowing that it is often difficult to schedule group training, the study suggests that the management representative works on a computer-based self training giving a good start to ISO 9001:2000. This kind of training can be bought online at 350$ and

[12] The management representative will be referred as MR in the study

serves up to 50 employees (SecurSoftware has 37 employees). The training is an interactive one with slides, audio and includes measurement of effectiveness in the form of quizzes that must be passed to receive a training certificate.

Step2: Project Plan Preparation

Implementing a quality management system is a project that should be monitored in order to succeed. Therefore, before the MR starts planning, he should set goals for the project and must determine a timeline table showing the start date and target end date together. Other criteria are also important to note like identifying project responsibilities, steering team. Appendix C presents a sample for a project plan where all basics information can be documented.

Step 3: Steering Team Identification

The steering team is a team led by top management to coordinate and lead the implementation of the project. The members of the steering team should include representatives of all functions of the organization - marketing, design and development, planning, production, quality control.

SecurSoftware has all needed human resources to form a successful steering team. The management has to officially designate the team members and then the latter can be prepared using the computer-based self-training.

The job of a team is as follows:

- Identify team members for each operation procedure.
- Assign target start date and completion date for each team.
- Identify training needs for employees and schedule training sessions.
- Meet on a regular basis to evaluate progress, answer questions for the teams and evaluate resource needs for the implementation.
- Review and approve procedures as they are finalized.
- Choose a Registrar from where the company can get its ISO certification

Step 4: Gap Analysis

One of the first steps in the QMS implementation project is to compare the current quality system to the requirements of the ISO 9000:2000 standard. This is called a **Gap Analysis**. To do so, the MR must use the Gap Analysis Checklist. This

checklist contains the five sets of requirements that make up the ISO 9001:2000 Standard, written in question format. The MR or a team chosen by the latter must do the gap analysis. Refer to Appendix D to read about the complete checklist contents.

Several questions from the checklist were used in the interviews done with the management to be able to define the overall quality situation in SecurSoftware. In addition, with the help of the current quality manager Mrs. Carmen Keldawy Alouan, quality inspection was introduced in the production phases to get quality product. Chapter four will show the new different processes of the technical department named respectively: inception, construction and validation. The processes' designs will be done with the help of a task team chosen specially for this study (step 5 explains the task team job).

Step 5: Task Team Identification

The steering team selects the task team. Its job is to:

- Compare the requirements of the standard to the current process used at your company.
- Design a new process, or modify the current process so the company will be meeting ISO 9001:2000 requirements
- Write a procedure for the new process, and give it to the ISO Steering Team to review
- Introduce the procedure to employees if accepted

Knowing that I was a member in the quality department, I chose by myself a task team that helps in designing the new processes of the technical department. This team includes: a software engineer Miss Mireille Massaad, a project manager Mr. Simon Beujekian, a test engineer Miss Maya El Hajj and a quality manager Mrs. Carmen Keldawy Alouan. Chapter 4 will presents in details the processes, procedures and work instructions related to the technical department. In addition, the introduction of chapter 4 explains the reason why the study chose to evaluate the technical department.

Step 6: Quality Management System Documentation Development

Once the organization has obtained a clear picture of how its quality management system compares with the ISO 9001:2000 standard, a documentation of the quality

management system should be written. It contains documented statements of a quality policy and quality objectives called the quality manual, documented procedures and records required by the standard ISO 9001:2000 (these procedures are done when all processes of the company are identified and re-designed) and the documents needed by the organization to ensure the effective planning, operation and control of its processes. Refer to Appendix F to check the quality manual main contents.

As for steps 7 till 11, they deal with the implementation and post-implementation stages. They are respectively as follows: implementation, internal quality audit, management review, pre-assessment audit, Certification and registration. The details of each step are shown in appendix E. Yet again, the focus of the study deals with the evaluation of the current technical operations and re-design of new processes in order to enhance the software development operation as a whole.

3.2 ISO Major Clauses and Gap Checklist Results

This section describes the major 5 clauses of ISO 9001:2000 in brief. This part of the research is dedicated for these requirements mainly to demonstrate that ISO can drive any company of any size and any type of product provided to effectively restructure its system and most importantly to continually improve its system due to its generic requirements. Any requirement in clause 7 that cannot be applied due to the nature of the organization or its product can be considered for exclusion. The next part is a brief analysis of the current SecurSoftware situation regarding the effectiveness of its system as well as the quality of its product. Detailed solutions are proposed in Chapter four together with the new process models designs.

3.2.1 ISO 9001:2000 Major Clauses [13]

Clause 1, 2, 3- General

The first three clauses are respectively Scope, Normative Reference, and Terms and Definitions. These 3 sections are like an introduction that explains the scope of the

[13] The contents of the major ISO clauses were summarized from chapter 5 section 6 under "Brief summary of ISO 9001:2000 requirements" of the following book: Tricker, Ray and Sherring-Lucas, Bruce. 2005. ISO 9001:2000 in brief. Amsterdam: Elsevier/Butterworth-heinemann. p. 119- 124

QMS, the vocabulary to be used conjunction with the standard itself and some terms and definitions.

Clause 4 – Quality Management System

This section contains the documented methods of how an organization directs and controls quality. All methods are listed under the quality policy, quality objectives and the quality manual.

Clause 5 – Management Responsibility

As leaders of the company, managers have made a commitment to the quality management system. They are required to identify all the relevant business policies and procedures, allocate resources to ensure implementation, maintenance and continual improvement of the quality management system.

Clause 6 – Resource Management

The day-to-day management of quality and effectiveness relies on using the appropriate resources for each task. These include competent staff with relevant knowledge, skills, and training, the correct tools, equipment and supportive services.

Clause 7 – Product Realization

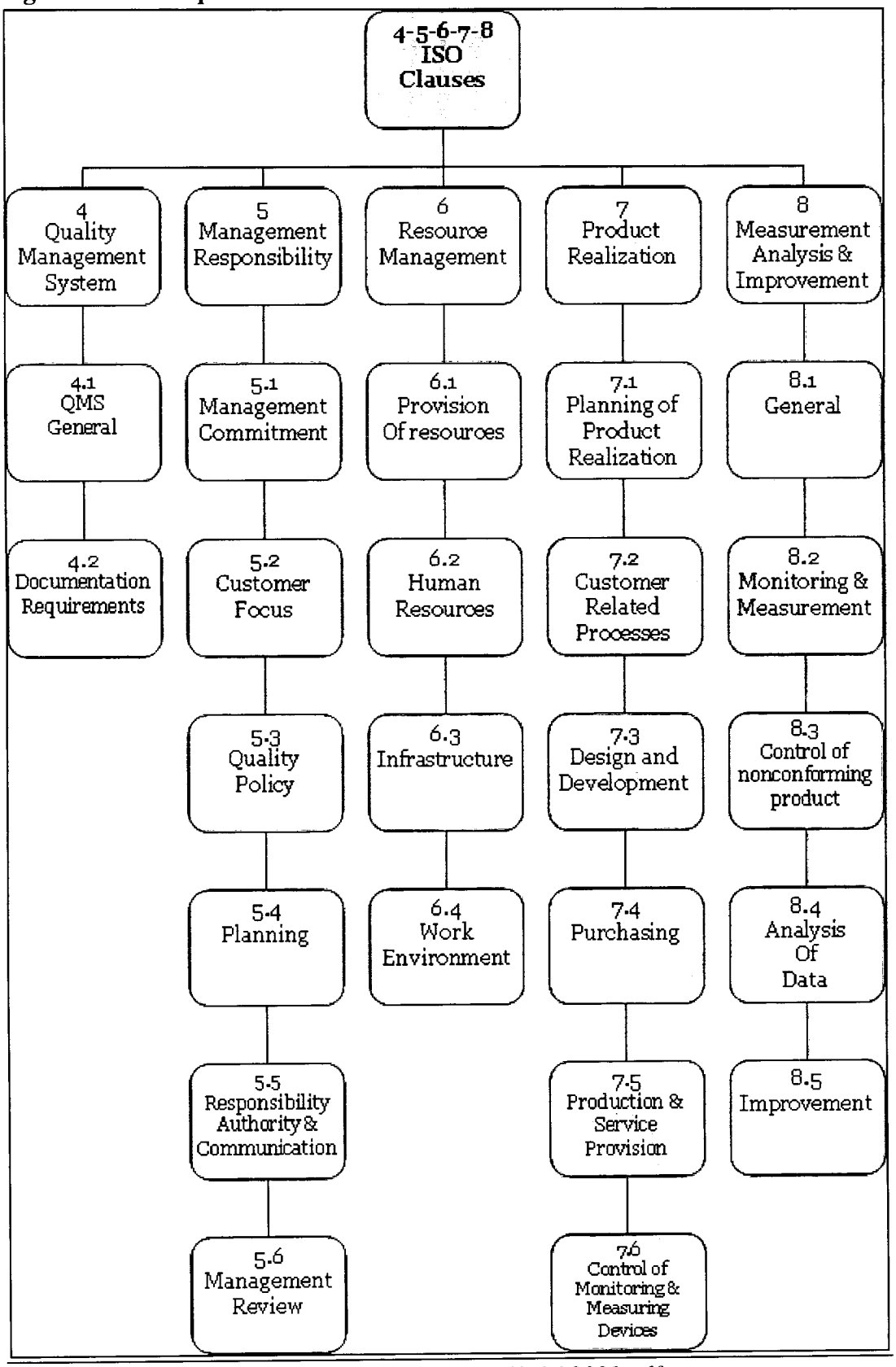
This section covers the steps in the operations that provide the company products and services. These steps include: determining and matching customer requirements, development, design, sales, purchasing, production / operations, delivery controls, etc.

Clause 8 – Measurement, Analysis and Improvement

To achieve success in business, measurements and analysis help to improve your company's performance, organization and compliance. Statistical techniques should be used where necessary.

The figure below (figure 6) schematizes the different subsections titles in the main five ISO clauses.

Figure 6: ISO Requirements Sets



Source: www.spectrumqa.com/pdf/ISO9001.pdf

3.2.2 Gap Analysis Result

After the interview done with the CEO and the technical department manager plus the answers of some of the gap analysis checklist questions, a clear view about the current company situation has been drawn. SecurSoftware has a very shy quality system. The problem resides in the fact that all software operation phases are not well documented and done chaotically. They are all controlled directly by the same person who is the project manager. Documentation is weak, main titles are missing, dependency on few people is noticed, and ignoring each other job tasks and duties is a normal fact.

The main issue programmers are facing is the unplanned code that is becoming most of the time the production code. Beside, they are using legacy pieces of software for some of the application. These software applications have no updated documentation knowing that they were developed years ago.
Second, as developers they need two documents to design the code on specific requirements using unified function formats and classes: a business development plan (BDP) and the software architecture document. These documents are missing for most of the projects or written in a sketchy way. Consequently, confusion, missing customer requirements, bad time estimations are the results.
What should be done is to update the two main documents to be in compliance with clause 7 section 4 of ISO requirements and integrate them in the new processes as a major step to pass by.

As for the quality department, problems came first from the developers who underestimate the importance of test engineers, and more precisely the importance of testing even in the very beginning phases. What is really happening is that the software application is being tested when all code has been written. So test engineers take the application in the last phase where bugs' fixing is very critical for the timescale of the project as well as for its budget.
What this study considered to be beneficial is to include in every phase of the software development the testing operations. Consequently, the outputs of the design and development will be provided in a form that enables verification against the design and development input therefore output is to be approved prior to

release. This will be in compliance with clause 7 section 4, design and development

The second problem came from the department itself. The test manager does not have test plan to base his testing on it. What is really happening is that every test engineer writes his own scenarios on the spot i.e. he created them while testing and save them as a reference for the next release testing. No unified documentation is available but one: the testing records. All bugs found are written in these records. They are organized by date and release number.

Again, this issue is reconsidered by designing a test plan template and test case template to help the test engineers to achieve a better quality product. The contents of these templates will be described in chapter 4 with the new models for the software development processes that are compliant with ISO 9001:2000 certification requirements.

3.3 Primary Data and Information Collected

To be able to build a new efficient company structure, one must understand the deficiencies in the existing system in details. Knowing that ISO 9001:2000 gives common theories and rules for all companies and not unique processes to be applied, this study cannot rely only on ISO 9001:2000 notes to design a complete, customized ISO implementation plan for SecurSoftware. What this study needs is the experience of people working in the company and their comments on the existing structure. Consequently, the main source of data used in this study is the observations of some people selected according to the relevance of their jobs in the company's production operations.

Primary data was collected from several employees with different backgrounds and thus work experience. The list below fine points the different source of information:

- *Interview with the project manager*: the study collected information about the problems faced during the current production system and processes (Refer to chapter 4 for more explanation about the old processes sequence).
- *Meeting with one system analyst, one software architect, the quality manager and a team leader*- the one responsible for the code development part. The titles of the meeting subjects and the data collected were respectively as follows:
    - Reasons of delaying software application delivery

- Reasons behind finding big number of bugs in late releases
- Failing to achieve code optimization
- Failing to bring the system to its maximum capacity
- Collection of old standard documents like the software architecture templates, business development plan template and test plan template.
- Revision of some projects history and analysis of the notes related to the projects.
- Setting tentative processes designs

- *Employees' personal experience*: relevant data was collected from the employees' comments and observations. The study interrogated employees with at least 3 years of experience in the company. Each one of them presented his cons and pros concerning the current structure. Beside, I added my personal experience to this study; knowing that I worked in SecurSoftware for 4 years. I worked as a test engineer, a system analyst and on the customer support. The study benefited from the diversity in my work experience because I was able to observe and feel the deficiencies in the system from the inception of the software as a system analyst to the candidate release as a test engineer till the post release on the customer support.

In conclusion, this study used, as secondary data, the literature review presented in chapter 2 and software oriented books available in SecurSoftware library (reference of books are listed under References section). However, these data were useful only to set an idea about how to start with the QMS implementation, and to understand the different phases and needs of the software development process.
On the other hand, the primary data was of big support for the research. As it stated previously, implementing a new quality management system and updating company's processes need little but relevant details about all what is going on in the company. Those details are only available in the employees' judgment and thoughts.

Chapter 4

Implementation of ISO to SecurSoftware

ISO 9001:2000 expects an organization to identify processes required for production of high quality product, determine their sequence and interaction with one another, design and document each one of them, and finally improve effectiveness of the system in a continuous way. This is the rule. This chapter designs a general model for the company to comply with ISO requirements.

The main study is done on SecurSoftware technical department. This department is the heart of the company where the production of software is done. The chapter emphasizes on the purpose of each single process of the software development cycle as well as its contribution to the production of quality software. The designs are based on the ISO clauses rules. The target of this implementation part is to present to the management a complete image of an efficient system that drives the company to an environment of continual improvement. The purpose is not to get the certification; but to utilize the ISO 9000 model as a benchmark to improve the adequacy of the company operation system.

4.1 Company's Processes

The old processes are identified and new ones are added. The new processes are essential for the accomplishment of a complete QMS. In the table below, the study divides the processes according to the category they belong to: the realization, the supporting and the improvement one. These 3 categories are created with the help of figure 1 in section 2.1.2. This process grouping is graphically shown in the next section under interrelated processes flowchart, which presents a logical software production approach.

Table 1: SecurSoftware Processes Grouping

Old Company's Processes	Proposed Processes	Category
Construction	Inception	Realization Processes
	Construction	
	Validation	
N/A	Warehousing Publishing	
Purchase	Purchase	
Client Support	Client Support	
Billing	Billing	
Marketing	Marketing	
Human Resources Management	Human Resources Management	Supporting Processes
Employee suggestion	Employee suggestion	
System administration	System Administration	
N/A	Documents control	
N/A	Records control	
N/A	Internal audits	Improvement Processes
N/A	Corrective & Preventive actions	
Client Claim	Client Claim	
N/A	Non conforming products	
Management review	Management review	

Major modifications are made to fit the ISO requirements. The study begins by updating the existing procedures in the realization processes category (construction, purchase, client support, billing and marketing). Every procedure needs to be redesigned in order for the quality verification to be included. Therefore, changes are related to:

- Defining the players in each process
- Defining the employee job description
- Adding quality testing phases in each process

The major change in this category is related to the old construction process. The study divided it into 3 main processes (inception, construction and validation)

essential for the development of a quality software product. Each one is presented in a diagram form in the next section.

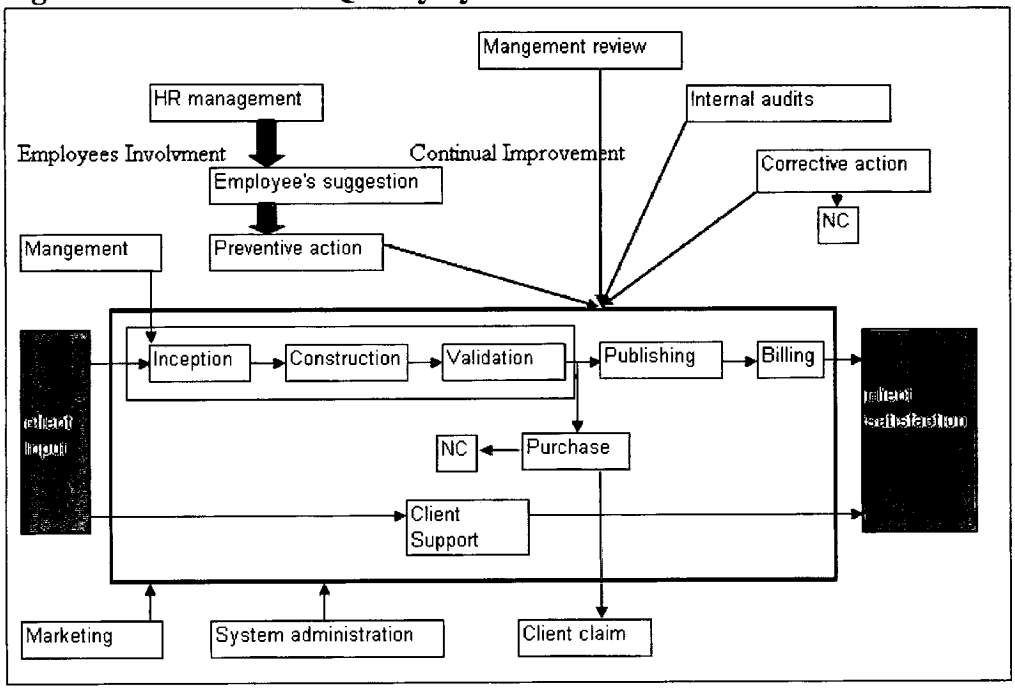
As for the supporting process, documents and record control processes- which are the core of the ISO standards- are added.

No continual improvement strategy is identified in SecurSoftware thus the entire improvement process needs to be created from scratch. The study includes in this category, basic processes namely the internal audits, the corrective and preventive actions and the non-conforming products. If these latter are correctly applied, the company can seek to develop more scrutiny to the current operations in order to achieve an absolute continual improvement strategy filling all the current gaps.

4.2 Interrelated Processes Flowchart

All processes, the old ones and the newly created ones, need to be interrelated in a way that complies with ISO requirements. The study refers to figure1 (Interactions in ISO Processes) in Chapter 2 under the revised ISO 9000 standard section, to design the process organizational flowchart. This functional flowchart defines the main and the related sub function within the company as well as their management.

Figure 7: Interaction of Quality System Processes



4.3 Realization Process

To efficiently realize a specific product, the management should determine the following criteria as appropriate:

- Quality objectives and requirements for the product.
- Needed processes, documents, and resources specific to the product.
- Required verification, validation, monitoring, inspection and test activities specific to the product and the criteria for product acceptance.
- Records needed to provide evidence that the realization processes and resulting product fulfil requirements.

The following subsections deal with the main processes under product realization, which are the core of the technical department. They are bordered by the red line in figure 7 above below. These processes are explained in details and all previous listed points are integrated in the new process' models.

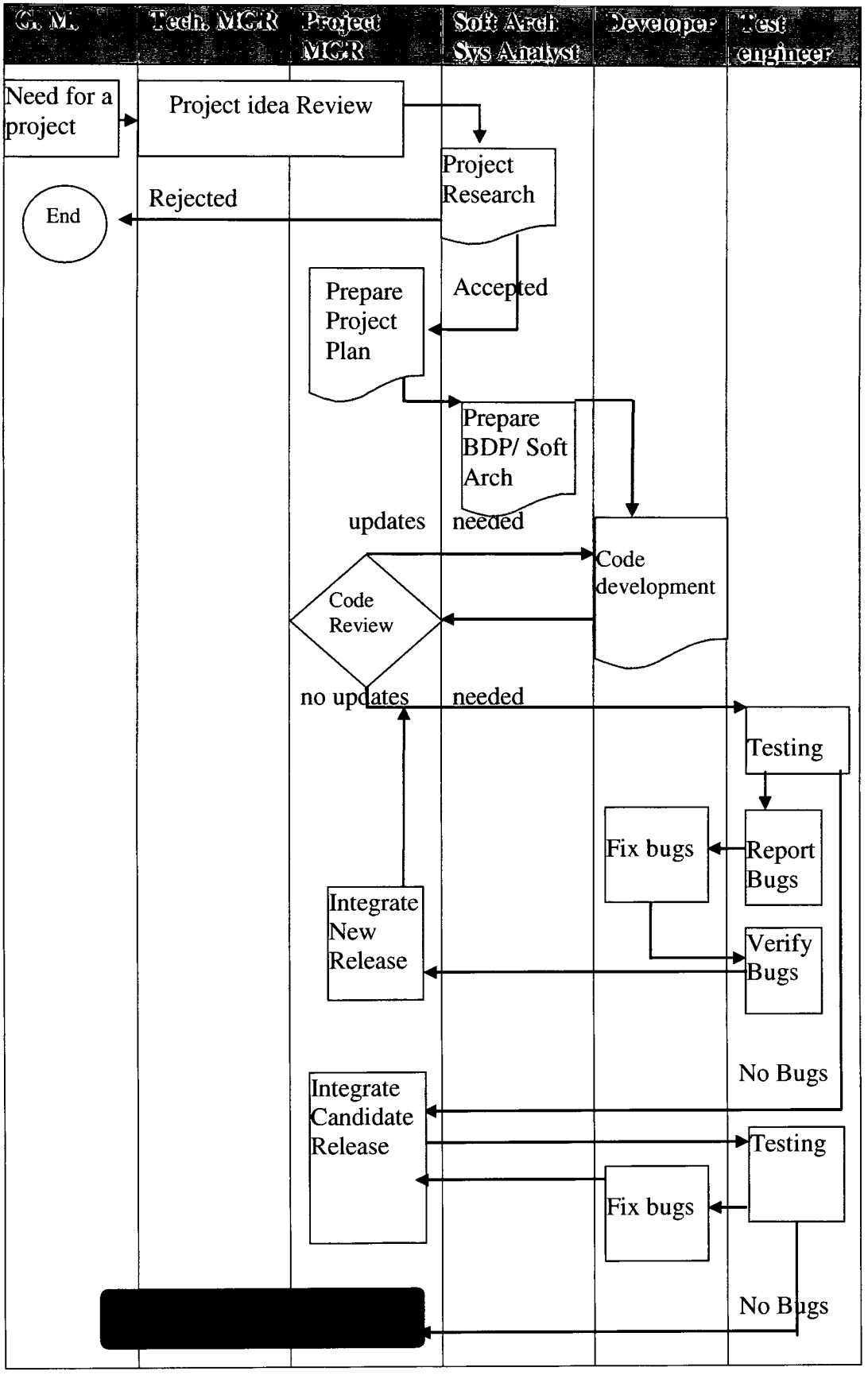
4.3.1 Old Software Development Process

A quick summary explaining the real situation in SecurSoftware when it comes to produce new software is as follows: when the CEO or the technical manager has an idea for a project, a meeting discussing this idea is done gathering only top management. If the idea seems to ensure success then the R&D officers do their research and give the pass or fail tickets to the technical department. Therefore, almost all projects enter the construction phase without any official document defining objectives, scope, purpose and deliverables to be produced.

Quality checking is missing in the construction phase. The job of test engineer is required in the last phase, i.e. the validation phase. The issue is that some bugs found are related to software analysis and design. In order to fix them, the entire procedure, from the inception step till the validation one should be redone. Now, we can understand why the projects are stopped in late phases causing loss of money and time.

The below figure presents the old process model used in SecurSoftware when developing software application:

Figure 8: Old Software Development Process



The abbreviations in the above figure are as follows:

- BDP refers to the business development plan where project vision, problem, requirements, functions and features are explained, as well as other important project procedures. (Refer to appendix F for more details concerning the BDP).
- Soft Arch refers to software architecture where the design of all modules and sub-modules for the system being developed is drawn. (Refer to Appendix F for more details about the global and detailed software architecture).

The study divides the old process into 3 phases: Inception, construction and validation. The target of such restructuring is to better control the quality of the software being developed.

If we analyze the old structure, the three proposed phases are integrated in it but not visible or clear for project team members. What is missing is to identify each phase alone, set goals for it, control it and finally define its input as well as its output. This way, confusion and chaos concerning software requirements, code development and software testing will be resolved. The next section presents models for the 3 proposed processes.

4.3.2 Proposed Inception Phase

Adding a well organized inception phase helps establishing the project's scope and vision; that is, establishing the business feasibility and stabilizing the objectives and the expected output which is a software operating efficiently and according to the customer requirements.

The outputs of this phase are the following documents: Business development plan, Global software architecture, Primary test plan and Project plan. These documents summarize the following points:

- External and internal environment of the organization in which the software is being developed
- Budget and schedule of the project
- The vision, scope, problems and risks of the project
- Business requirements, solution proposed, resources needed, deliverables
- Major features, modules and sub modules of the software
- Testing types to be performed on the software

Inception phase benefits

The outcomes and the benefits of completing all the proposed inception process steps are as follows:

- Multiple players are involved in the process (general manager, technical manager, project manager, software architect, system analyst, project reviewer and test manager). This way the confusion between team members about project inputs and outputs is solved.
- Internal documents essential for an efficient software production will be identifiable, controlled and stored in SecurSoftware database (BDP, software architecture, test plan, project plan).
- Quality records are established in very early stages (test plan), reviewed and maintained to provide evidence of conformity to requirements. This way the quality records will remain legible, readily identifiable and retrievable.
- Time and money saving for the construction phase. All documents identified in this proposed phase will reduce the code development task time by 30 to 35[14] percent. Usually, code development task of medium size project takes between 2 and 3 months to be completed. Using the proposed structure, SecurSoftware is able to complete the latter task in 1.5 to 2 months.
- High risk elements of the project are eliminated by thoroughly studying the application environment from its inception.

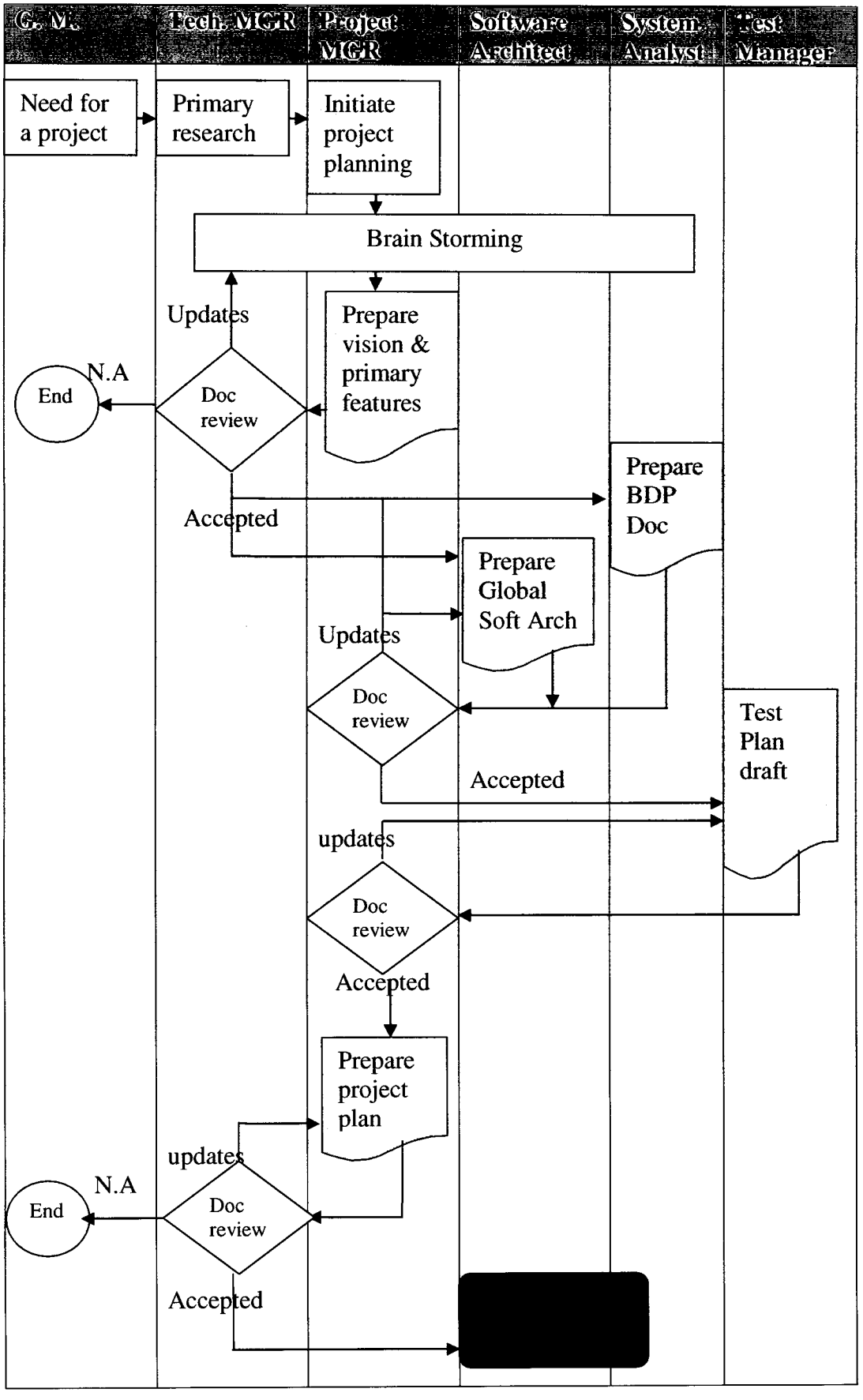
Inception phase Inconveniences

The new designed inception process has no disadvantages; instead some difficulties will show while applying it.

- Documenting required reports (BDP-Soft Arch-Test Plan) is time consuming for the employees. If they do not understand the need to archive such reports and their relevance to the software application, difficulties will show while writing and updating the reports.
- The completion period of time of the new inception phase will be much longer than the old one, considering the new required outcomes of the process. This issue may confuse the entire team. Therefore, the team is obliged to change his working routine and get use to the new system.

[14] The percentages are based on the project manager forecasts and experience in the company and knowledge of employees' capacity.

Figure 9: Process Inception Product

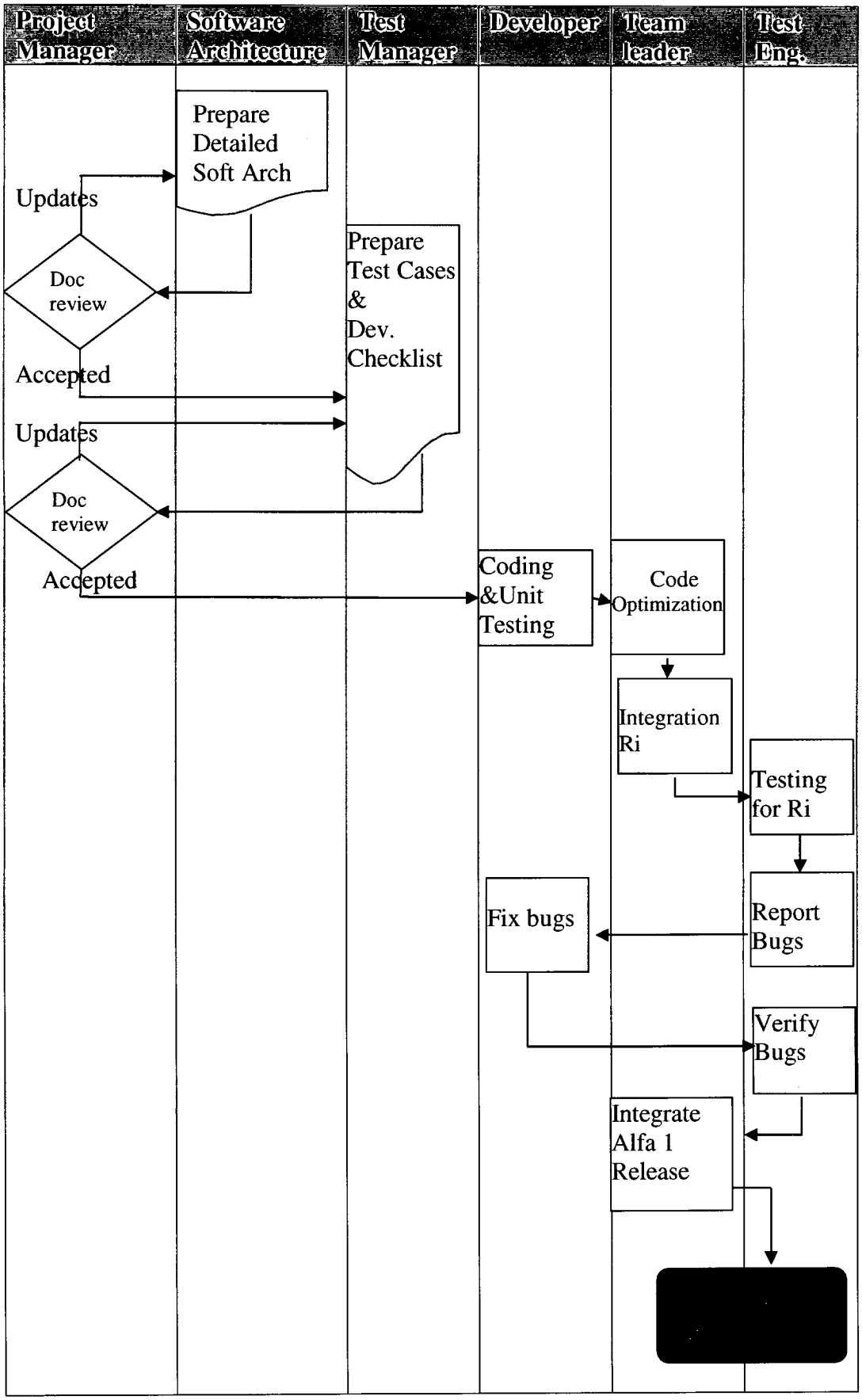


4.3.3 Proposed Construction Phase

During the construction phase, all components and application features are developed and integrated into the product, and are all quickly tested. The construction phase is, in one sense, a manufacturing process where emphasis is placed on managing resources and controlling operations to optimize costs, schedules, and quality. The inputs of this phase are the documents written and approved in the inception phase. The contents of the documents will be used as reference and guide for developing the software application. The outputs of this phase are the detailed software architecture, the detailed testing plan and the alpha 1 release of the software to be tested in the next phase. This release is the first official one where all modules are integrated.

In the model below, the detailed software architecture is referred to as Detailed Soft Arch; the developer checklist is referred to as Dev Checklist. As for the Ri, it refers to the release number (R1, R2, R3...) of the modules being under test.

Figure 10: Process Construction



Construction phase benefits

The outcomes and the benefits of using the new model below (figure 10) will show as follows:

- The company can assure a decrease in the number of bugs that are found in the validation process. This is because of the developer testing checklist document which is used to verify modules functionality before integrating them in one big release. In all project, almost 55% of bugs are related to the modules' controls. These bugs can be eliminated by 80 % if the developers check them while writing code. With experience, developers can test these control in less than one day; it depends on the module's size.
- The developer checklist includes many testing types[15] as: the standardization testing[16], the GUI testing[17], Validation testing[18] and the Functionality testing. This checklist will be written based on a template created by the test engineer and the project manager. Consequently, this list guarantees that the application is tested using all types of testing procedure.
- The template will be used by the auditors as a benchmark to asses the software's quality.

4.3.4 Proposed Validation phase

The main purpose of this phase is to test the application fully in order to promote it as a quality product in the market. The major inputs of this phase are the alpha 1 release and the detailed test plan. Test engineers will use the test plan as a guide to test the Alpha 1 release of the application. The output of this phase is the application itself approved by the project manager as working efficiently under the customer requirements using high quality control measurements..

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[15] Software Haug, Michael, Olsen, Eric W and Consolini, Luisa. 2001. Software quality approaches: testing, verification, and validation. Berlin: Springer.

[16] Standardization testing means that the application being developed should have standard look and feel like any other window application

[17] GUI testing is the process of testing a graphical user interface to ensure it meets its written specifications

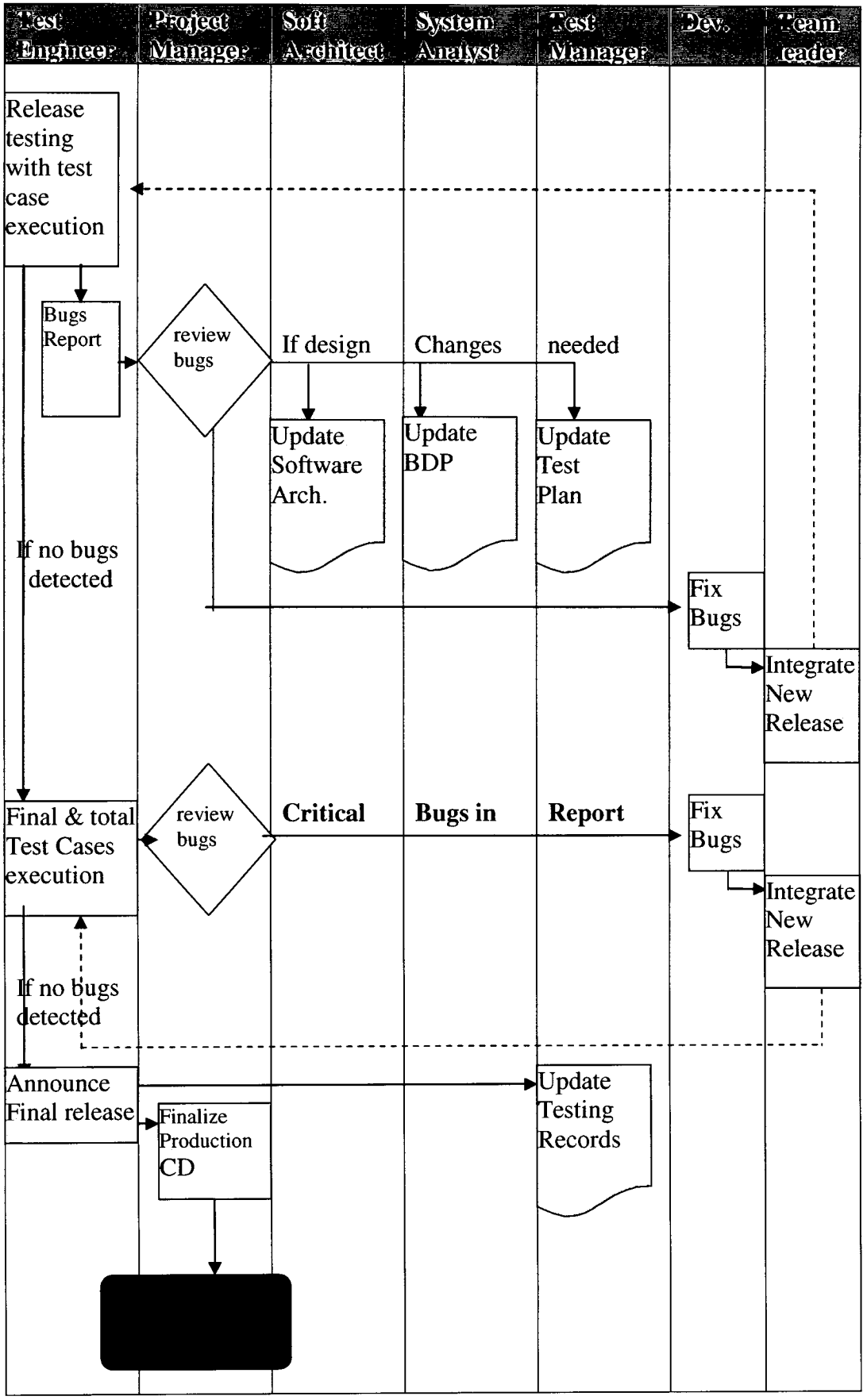
[18] Validation testing mainly depends on the fields set in the dialog box and the functions it has to perform.

Validation phase benefits

The benefits of using the new validation process (figure 11) will be as follows:

- The new process is designed in a way that allows the management to record every update in the software production operation and thus keep them for auditors. This process keeps track of every bug found in the software from the beta 1 version till the candidate one.
- The process obliges the persons in charge to update their documents so that the project can be understood by potential players (new developers who want to work on the project in the mid phases, internal and external future auditors)

Figure 11: Process Validation



In conclusion, if the above processes' updates are applied, SecurSoftware is able to plan and control the design and development of projects effectively and efficiently. The outputs of these processes are:

- The inputs related to projects are archived into records, named the Business Development Plan (Appendix F defines the main section in the BDP template).
- The outputs of the design and development are provided in a form that enables verification against the design and development input and are approved prior to release. This part is backed up by 4 main documents namely the Test Plan, the Global Software Architecture, the detailed Software Architecture and the Developer checklist (all the templates are presented in Appendix F). The Developer checklist already existed in SecurSoftware but not applied by developers. All other documents are created from scratch with the help of the staff.
- Quality improvement:
  - At suitable stages, systematic reviews of design and development are conducted. At the end of the elaboration phase test plan and software architecture are reviewed against the business development plan.
  - At every step of the process, a specific player will be responsible to verify that the design and development outputs have satisfied the design and development input requirements.
  - The QA department verifies that the final product corresponds to the client vision by implementing functionality testing based on the input use cases.
  - It happens that the validation is undertaken by the client for intermediate Releases. The client is requested to report his/her comments if any using SecurSoftware website.
  - If the design needs to be changed, it should be verified and approved by all related authorities, and if a design modification is introduced, all previous documents (Business Development Plan, Software architecture, Test Plan) will be modified accordingly and have an incremented edition and a brief summary about the revision history.

4.4 Time Scale and Budget for ISO Implementation

In general, an ISO 9001:2000 implementation project typically takes about 6 to 9 months, but ranges from 3 to 20 months; this depends on external and internal

factors (the factors that may affect the company project are listed in the next paragraph). But before moving to the implementation phase, a project plan that outlines the path of SecurSoftware to the development of a QMS should be established. The study designed a 5 months project plan with the help of the head of all SecurSoftware departments.

First, the plan consists of 3 components:

1. Objective and resources
2. Time frame of the activities and budget
3. Conclusions about the factors that may affect the timeline

Objectives and Resources

The project's objective is the development and implementation of a QMS complying with the requirements of the ISO 9001:2000 Standards. The QMS has also to meet the needs of the organization properly. The resources that are to be used are members from each section of SecurSoftware and one consultant. The project team members come specifically from:

- Human Resource department
- Finances and accounting department
- Technical department
- Purchasing and Logistic department
- Marketing department
- Consultant: an expert on ISO 9001:2000[19]

Time Frame of activities and budget

Going back to section 3.1 "introducing ISO to SecurSoftware", the 12 essentials steps for the project are explained in details.

Section 3.1 emphasized theoretically on the steps needed for the implementation; this section deals with the time and budget needed for each step. The study uses Gantt chart to illustrate the project schedule and budget. First, the project is divided into 4 phases listed respectively below:

1. Preparation phase

[19] The consultant will be assisted by the Project team members in order to gather information relating to their section or department. This is necessary to develop the elements and documentation of the Quality Management System.

2. Analysis phase
3. Implementation phase
4. External audit and registration phase

Preparation Phase

During the preparation phase, all employees are given sessions, 3 hours a day, introducing the important information one must know about ISO. These sessions are followed by a test. After this step, the steering and task team are identified. These two teams gather all relevant information on the organization, processes and systems currently existent in the company. As for the role of each team, you can refer to section 3.1. In this phase, only some consulting interference is needed. However, the consultant's – an outsider- job is essential to check on the identified teams and help them brainstorming the information gathered.

Table 2: ISO Implementation Timeline

Phase	Task name	Month 1	2	3	4	5	6	10	Hr	Bdgt $
Preparation	ISO Awareness training								15	350
	Steering team								10	
	Task team								10	
	Consultant review								15	750
Analysis	Gap Analysis								30	
	QMS documentation									
	Processes design								270 14	
	Consultant review								40	4000
Implementation	QMS Developm't								50	
	Staff training								120	
	Internal audit								40	
	System update								U15	
External audit and registration	Pre-assessment audit								30	3000
	Certification and registration								U	

Analysis Phase

The analysis phase is the hardest and the longest one. Based on this information gathered in phase one, the documentation for the QMS is established. As the chart

below indicates, a gap analysis is conducted. Appendix C shows the gap analysis questions in details. These questions are to be addressed for almost all company's employees. The QMS documentation, which mainly includes the quality manual, begins in parallel with the processes designs. Work instruction, procedures, templates are attached to each process created or updated.

Implementation Phase

The implementation phase is planned for approximately 2 months. During this period, the QMS is implemented and the relevant staffs participate to a training enabling them to fulfil their function and work according to the procedures and principles of the QMS. The relevant documents are distributed to the assigned destinations, their points of use, and the staff can start working in accordance with the documented QMS. After the implementation is progressed a pre-assessment takes place by the same consultant. The new QMS should operate at least few months to be stabilized before asking for the certifications. I gave the system 3 months trial which is equal to a quarter.

External audit and registration phase

During month 10, which represents the final month of the implementation, an onsite audit is carried out by the certification agency. If the certification body finds the system to be working satisfactorily, it awards the organization a certificate, generally for a period of three years. During this three-year period, it will carry out periodic surveillance audits to ensure that the system is continuously operating satisfactorily. We cannot tell about the fees asked by the certification agency, the reason why we notice the sign U for unknown in the chart above.

Human resources needed for the QMS are available at SecurSoftware but need to be organized. However, the management should re-assign for each employee new jobs adequate to the one in the processes. Therefore, no recruitment is needed for the QMS.

4.5 Factors affecting the implementation of the project

On-site application hides risk, limitation and obstacles, where the need to outline some of the issues that may show while working on the implementation plan:

- ***Complexity of the company***: SecurSoftware has 37 employees whose jobs are not well defined; i.e. no written job descriptions are available. The company's operations are most of time done in a messy way. Dividing job among employees and reassigning them new jobs may lead them to resist for such a change
- ***Existing system:*** Everybody got used to the old system. Switching to a new complicated one that requires documentation, follow ups and auditing may increase confusion and decrease, in the first period, employee motivation and thus productivity.
- ***Availability of old documentation***: modest quantity of the existing documentation can be used in the project. This issue may require lots of effort from the teams to gather relevant data. If the latter shows little motivation or feel desperate in some phases especially in the first one, where all old data needs to be collected and analyzed, the project timeline can be negatively affected.
- ***ISO expertise availability:*** finding an ISO expert is critical for the success of the project. Therefore, the company must find an auditor of good reputation to control the QMS development. In a way or another, if the consultant's advice is be understood or followed, we cannot guarantee a successful implementation.
- ***Management distraction:*** Some researches showed that the top management get distracted very early in the ISO implementation process and then abdicate the latter to staff or consultants. In the case of SecurSoftware, beginning a session explaining the impact that ISO has on the company's financials can motivate the management and reduce the risk discussed above.
- ***Work environment:*** the percentage of resource availability needed for the ISO implementation project will specify the risk degree of such a project. ISO implementation is in need of the following tools:
    - Education and planning tools are needed to gain management understanding
    - Documentation tools such as Sample Quality Manual and Quality System Procedures to help understand the organization's current process and aid in the brainstorming of how to structure and organize the quality system documentation.

- Training tools presenting to employees what they need to know about ISO 9001:2000
- Training tools educating the entire organization as to the purpose, value, and each employee's role in the quality system which is critical to successful implementation
- Measurement and data analysis software

4.6 Risks Linked to the Implementation of the Project

Section 4.5 lists in details the internal factors that may show while working on the ground in the implementation plan. While the impact of these factors - if happened- on the project are critical; external factors and post implementation problems will influence much more the success and continuity of the project. The list below summarizes the major external issues that the company may face:

- ***Political risk***

  Investing on a project like registering in ISO 9001:2000 is costly in the short run. The return on this investment shows in the long run. Consequently, planning for long term projects, in this period of time, when Lebanon is facing a very tense political situation, is risky.

- ***Strike effects***

  The country is experienced massive street protests, no working government and a series of bomb attacks. SecurSoftware offices are in Down Town Beirut- so the company is obliged to close its door every time a contest is noticed for the safety of its employees.

- ***Post implementation challenges***

  After the implementation phase is completed, the company will have a challenge to preserve its new system. Certification is not the important step; top management should always think about strategies that will keep them and the employees motivated about maintaining the certification and achieving continual improvement.

4.7 Implementation Results for SecurSoftware

This section will take an old project done by SecurSoftware using the old system and analyze it using the new proposed processes in section 4.3. The

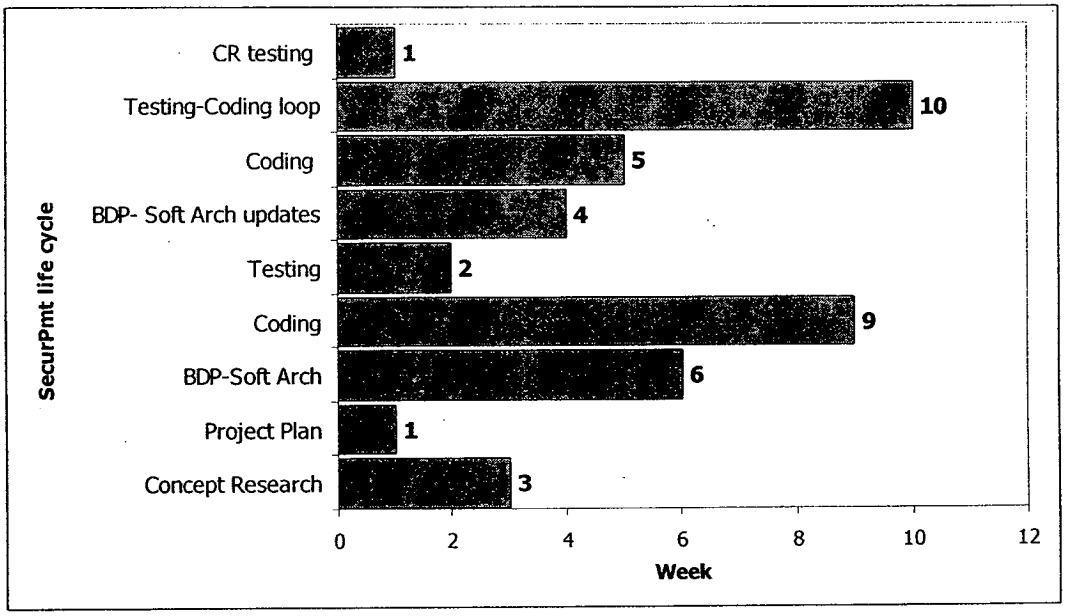
example focuses mainly on showing the reduction of the project time as well as the development of better quality software.

4.7.1 Evaluation of the new processes' structures

To be able to measure the efficiency of the new processes, the study must compare the development time and cost of any application using both processes' structures (the old and the new proposed one). The study analyzed an old application- SecurPmt, version 1.0- from SecurSoftware database[20]. This application is a comprehensive, easy to use desktop application that protects information from unauthorized access. It preserves data integrity and confidentiality, through access control using smart cards, encryption and data shredder application.

Figure 12 below associated each step of the software development cycle (from the project concept research till the candidate release) with the week number it took to be completed.

Figure 12: SecurPmt development timescale



Obviously, the major problem resides in the testing-coding loop phase where the application is being tested more than expected in order for the developers to fix all bugs. The application took 21 weeks to be developed and tested once, and 20 weeks

[20] The team who worked in this application included 9 members: 1 project manager, 1 system analyst, 1 software engineer, 1 team leader, 2 developers and 3 test engineers.

to be defined as candidate release. Spending approximately 50% of the project time fixing bugs is very costly. Giving up more time in the first steps, especially in writing the BDP and software architecture documents then communicating it through the entire team, will reduce confusion as well as time spent in updating design and rewriting code in later phases.

An important point is also the missing testing process during the design and coding phase to identify and fix bugs. Integrating quality checking in early stages of the software development saves time as well as costs knowing that the cost of quality increases by high rates every time the project approaches its final phase.

Another major problem is the free time that the different team members are spending waiting for each other's output to be able to continue the project. If we refer back to figure 8, each step is done by one member and there is no major interference by the other team members. This lack of communication is the reason behind the team low productivity.

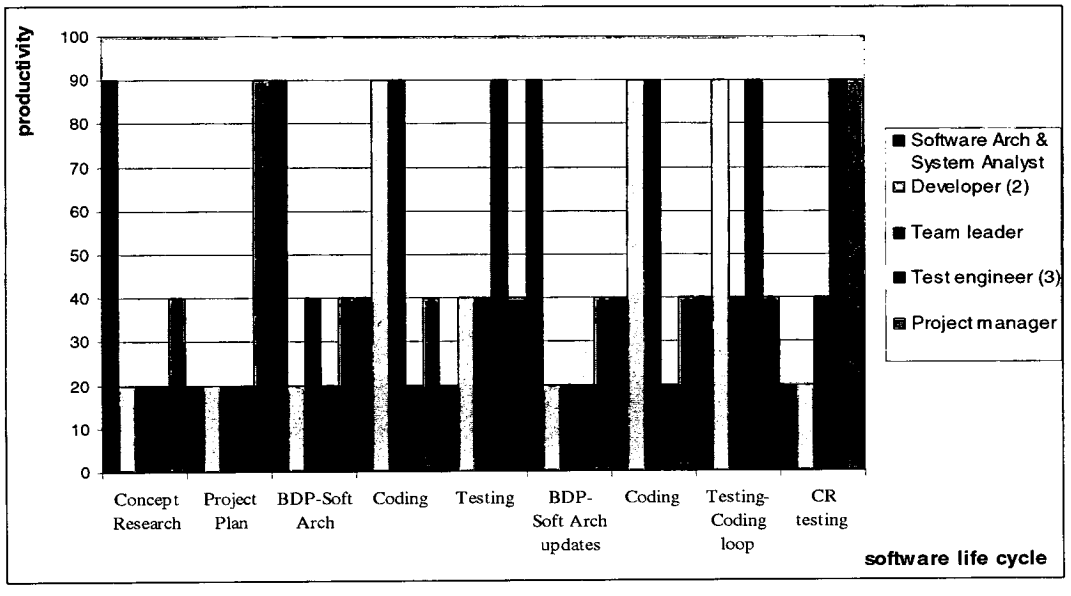
The study did a limited analysis of the team productivity. It divided the team members into 3 categories: high, medium, low productivity. It estimated that whenever an employee is working on a special task, his productivity is considered as 90% (classified as high). On the other hand, the employee who is waiting for a task to begin working is classified in the low category with 20% productivity knowing that he has some follow-ups and routine job to accomplish. The last category is the medium one which includes members that are helping high productivity employees in their task. These employees have 40% productivity. The productivity of each employee is defined using Figure 8 flowchart. The table below summarizes the idea as follows:

Table 3: Team Productivity

	Software Arch & System Analyst	Developer	Team leader	Test engineer	Project manager
Concept Research		20%	20%	20%	40%
Project Plan	20%	20%	20%	20%	
BDP-Soft Arch		20%	40%	20%	40%
Coding	40%			20%	40%
Testing	20%	40%	40%		40%
BDP- Soft Arch updates		20%	20%	20%	40%
Coding	40%			20%	40%
Testing-Coding loop	40%		40%		40%
CR testing	20%	20%	40%		

Figure 13 below is a graphical representation of the table above. It presents the different productivity level of each team member in each project development phase. Every bar is associated to one team member.

Figure 13: Team members' productivity



Obviously, there are gaps to fill with efficient tasks that surely reduce the cost of the projects and produce better quality product. If we only consider applying one strategy resolving employee free time, the company is able to increase the productivity/salary ratio, which will pay back by decreasing costs of the entire project, knowing that quality costs and project timeline are decreased.

What this study proposed to the management is a new strategy based on the new designed processes explained earlier in section 4.3.

To be able to compare the old and new system, the company must apply the new processes' structures. But knowing that these processes were not applied yet, the study will set estimation numbers concerning the project timeline phases and employees' productivity. These estimations are done based on the project manager and test manager judgments. The study consults the latter because of their long experience in the company, and more precise because of the team's -working on SecurPmt- knowledge, capacity and weakness.

The tables below are the estimated SecurPmt project timeline done using the new structure.

Table 4: Inception Phase

phase		task name	Week										
			1	2	3	4	5	6	7	8	9	10	11
Inception	new	primary research											
		features analysis											
	updated	BDP											
		global Soft Arch											
	new	test plan draft											
		reading doc											
		project plan											

This phase is almost new for the team. It solves the problem of confusion and repeated job; however, it requires documentation and frequent meetings gathering all team members for project issue discussions. This phase costs the team members, the following:

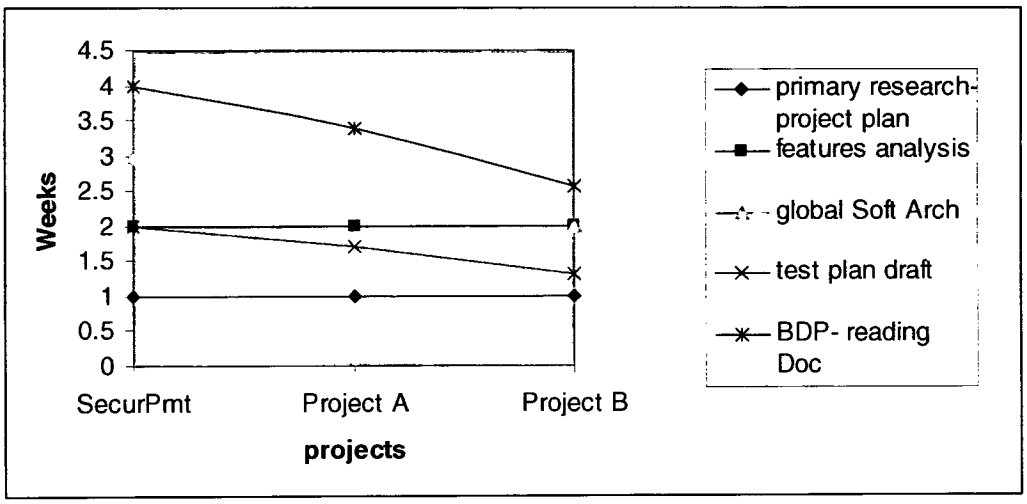
- Software architect, system analyst and test manager will have to write the documents in compliance with the templates approved by ISO. They should sacrifice extra time to get used to such writings.
- More productivity from the entire team members including developers and test engineers: they have to concentrate time for reading all required documents and discussing issues by conducting meetings with team leaders.

The required output of this new process takes time to be accomplished. Using the old system, this phase takes 4 weeks. With the proposed process, the team works 11

weeks to be able to start going into the details of the project. The objective of the new inception phase is to reduce the time of the testing coding loop where bugs related to design are being fixed and could be caught from the early beginning of the project. These errors are costing the company money, delays in project delivery, thus integrity towards customers.

Now, if we consider that we have 2 projects (medium-sized) a year and the team members will be able to reduce some inception phase's steps by 15 % and 25% respectively on each project, the phase timeline would be as follows:

Figure 14: Inception Progress Over One Year



With experience, the team will be able to finish the phase within 8.5 weeks. (Refer to appendix G for more details about new time calculations)

The construction process takes the longest time to be achieved and requires interference from the entire group. The table below shows the way tasks are divided along the 17 weeks.

Almost all tasks are new to the team. The common step between the 2 processes (the old and new one) is the coding part which takes 9 weeks. The other steps in the new process costs the company 6 additional weeks to be completed (highlighted in blue in table 5 above).

Table 5: Construction Phase

phase	task name		week															
			12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
construction	new	detailed soft arch																	
		test cases																	
		developer checklist																	
		coding-integration R1													R1				
		module testing																	
		coding-integration A1																	A1

The benefits of the new construction phase show during the process itself and the validation one. In the same process, the coding and integration (R1) step are completed faster because of the detailed software architecture that help the developer better organizing and writing the quality code thus better fixing bugs. Better quality code together with the developer checklist and the predefined test cases reduce the testing phase time and the testing-fixing bugs loop.

Now, with experience, the team can reduce the 6 additional weeks needed for the new process to 4, as follows:

- The software architecture can be written and reviewed faster when the writer is used to the different sections required in the documents and when previous code functions are used in new projects. This step can at maximum be reduced by 25%.
- The test case document is unique for each project. So the experience in writing it helps reducing the time by maximum 15%.
- The module testing phase should be taken from 1 to 2 weeks cause the main functional testing is being done during testing

What the management should work on is the coding-integration phase where evaluation of the developers and test engineers tasks should be done. Upon the assessment results, the management must give the team members adequate training and sessions in order for them to produce better quality in less time, therefore the coding-integration part can be reduced up to 35%.

The new construction phase timeline comes after one year as follows:

Table 6: Construction Phase after One Year

phase		task name	week												
			12	13	14	15	16	17	18	19	20	21	22	23	24
construction	new	detailed soft arch	■	■	■										
		test cases			■	■	■								
		developer checklist			■	■									
		coding-integration R1			■	■	■	■	■	■	■				
		module testing					■	■	■	■		■	■		
		coding-integration A1											■	■	■

The last phase in this new structure is the validation where the different application releases are being testing till the candidate one. This phase corresponds to steps testing till CR testing in the old system where it took 21 weeks to be completed. This phase is the critical one where the test engineers have the responsibility to find all the application bugs. This step cannot be reduced by time, but experience increases the rate of bugs found as well as their criticality.

Table 7: Validation Phase

phase		task name	week												
			29	30	31	32	33	34	35	36	37	38	39	40	41	42
Validation		B1 testing	■	■												
		bugs fixing		■	■											
		integration b2				■										
	new	documents updates				■										
		testing/fixing loop					■	■	■	■	■	■				
		integration of CR											■			
		final testing												■	■	
	new	documents updates														■

As a final point, considering that we are taking the best case scenario, project like SecurPmt size and contents can be done with approximately 35.5[21] weeks instead of 41. Beside the time reduction, the company is producing better quality software,

[21] The inception phase will take 8.5 weeks, the construction 13 weeks and the validation 14 weeks

training its employees to do professional work, and reducing budgets for each project thus increasing income. Investment in a quality system management does not pay back within one year or 2; it is a long term investment, a changing culture that needs commitment from all companies' levels.

4.7.2 Study Contribution to SecurSoftware

This study proposed for SecurSoftware management a solution that solves all current and potential problems related to management, software products and employees.

A well designed and implemented Quality Management System, based on ISO 9001:2000 provides the firm with bottom-line benefits:

1. Improve Operational Efficiency: Implementing the proposed processes presented in section 4.3 produces an entire different output. This output is developed under better process control and flow, with better documentation of processes and greater employee quality awareness. The operational efficiency is also showing with the reduced production costs. These reductions are caused by less product rejections and rework, fewer mistakes and better code quality which need less testing- fixing time.
2. Gain Access to New Markets: when SecurSoftware will be registered under ISO, new markets will start demanding its product. These increasing demands will accelerate sales and thus earnings.
3. Meet Customer Requirements: SecurSoftware will be able to achieve better customer satisfaction by offering essentially quality software with almost no crash time and no quality failure.
4. Develop effective supplier partnerships: Many organizations are asked by a customer to obtain registration as a requirement to do business with them. SecurSoftware will be able to sign deals with companies registered in ISO and thus improve its image in the market and between businesses
5. Achieve professionalism: When implementing, basing the management on a QMS strategy, SecurSoftware organizes authority and responsibility within the company. It insures that all employees:
    - Have the right job in the right time.
    - Are being trained and assessed.

- Are involved in all projects
- Are not confused with project outputs
- Are referring to official documents

The company insures that all projects are:

- Officially backed up, identifiable, controlled in SecurSoftware database.
- Quality records are established in very early stages, reviewed and maintained to provide evidence of conformity to requirements. This way, the quality records remain legible, readily identifiable and retrievable.
- High risk elements of the project are eliminated by thoroughly studying the application environment from its inception phase.

On the other hand, implementing a QMS costs SecurSoftware a price divided as follows:

- Money: investing in international standards does not come for free. The company has to pay for all required official documents to complete the registration. The cost is not restricted on the registration one, SecurSoftware will have to deal with an external auditor to track down the companies operations twice a year minimum.
- Time and effort: every employee in the company has to sacrifice time and effort for the quality management system. This QMS is involving everybody and requires time in the pre and post registration period. Employees have to be trained every now and then, attend seminars concerning quality and standards updates, and study and pass certification tests (related to their domain). Management is obliged to give time for monthly management reviews where all company's issues are discussed and solved.
- Chaos in the first period: Employees have to get used to their new job description and responsibility; they have also to understand the documentation part and reporting systems. The company might face chaos and confusion while starting with the new QMS
- Changing culture effects: the company has a challenge to adapt its employee to the new culture and new objectives. It may face resistance from some

employees. Dealing with employees' issues is critical because it is directly related to project performance, time and budget.

Some companies had greater success than others with their ISO implementations and some failed to achieve their target. To make an ISO implementation working, SecurSoftware management should recognize its crucial role in the ISO system management process. Moreover, ISO involvement and understanding should be at all levels, jobs, and areas. People should be trained on how to do their job, and to interact effectively with the whole system. Finally, dedication to the new system is the essential issue for the company in order to grow efficiently and move internationally.

Chapter five summarizes the limitation of the study as well as lists in details the recommendations for building and maintaining a successful quality management system.

Chapter 5

Conclusions and Recommendations

Achieving quality software is, somehow, an elusive goal. Most people base their estimates of a product's quality on its functionality and the appearance of user interface. However, the software industry determines the quality product by measuring its attributes, namely the reliability[22], testability[23], portability[24], extensibility[25], usability and maintainability[26] of the product.

This study took the case of SecurSoftware, a company operating in the software industry, that is showing potentials locally and internationally, but facing problems in its operations efficiency. The target was to plan for the introduction of a quality program based on ISO standards and mainly concentrate on problem prevention and early detection. The implementation plan focuses on how to incorporate quality inspection in the company's operations by re-designing, according to ISO 9001:2000 requirements, the 3 essential processes of the software development cycle.

The hypothesis stating that SecurSoftware can increase its operational efficiency if it implements a QMS was tested using the new proposed software development processes. The test applied the new system structure on an old software application taken from the company's database. It compared the development time of this application using the old and new processes. Results showed that the company saves time and money by applying the QMS proposed in this study. Knowing that the new system is not adopted yet by the company, the results were based on the project manager forecasts.

As a summary, the purpose of this study was to introduce to the company a new way of thinking and managing resources. The outcome of this research

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[22] Reliability is the degree to which the product meets its functionality over a measured period of time.

[23] Testability is the measure of difficulty in testing a product

[24] Portability is the measure of effort required to modify and test a product to allow that product to run in an environment other than the one for which it was developed

[25] Extensibility refers to the ease of enhancing the product

[26] Maintainability is focused on the effort in updating the product to deal with bugs in the system

demonstrates to top management that the firm is in need for a new management strategy. Again, this study has come with the following findings and results:

- Although, SecurSoftware is facing troubles concerning its operations and deficiencies in the company structure which is causing loss, SecurSoftware has the vision to become a global software development factory. Moreover, top management has the will to move to a better management strategy.
- SecurSoftware has all needed resources, especially the human ones, to efficiently optimize the capacity of its software production.
- ISO implementation project, if applied, will first result in:
  - Better operational efficiency.
  - Lower production costs by early detection of deficiencies, corrective action taken whenever defects occur.
  - Better system monitoring and reporting.
  - Retain and increase market share thus increased profit.
  - Enhance product quality because the latter is measured constantly.
  - Encourage continual improvement by making employees more clear about their job, objective, and company's target.

As a final point, such quality program is facing risks in all its stages. This study provided a section where external and internal factors, that may affect the ISO implementation project if applied, are listed. Yet again, these factors are related to the chaotic old company structure, the absence of project database, the political situation in the country and strike effects and finally to the post implementation challenges.

Likewise, this research is limited to some extent. Chapter 5 lists all factors that narrow down the study and affect the quality program design and then recommendations are given accordingly.

5.1 Limitation of the Study

Studying the implementation of a ***complete*** quality management system in an organization and applying it on all departments is time-consuming and costly project. Thus, the target of the study was not to present a total ready-to-use implementation project. The target was to make obvious to the management the

importance of integrating a well-known international standard like ISO in the company's system and present a simple map for applying it.

So, the major intentional limitation was by analyzing the condition of no more than one department, which is the technical one where I worked for 4 years.

On the other hand, some unexpected constraints arisen while working with colleagues and conducting the study. The major two limitations are listed below:

1. Confidentiality of financial tables

Productivity of employees was essential for the budget estimation in table 2. What we could do is the estimates concerning the hours needed for each step. But we needed the productivity measurements for each employee to calculate its decrease while working on the project. Such secrecy made impossible for us to complete the budget estimates of the implementation project.

2. Absence of documentation concerning old software project

For each new process designed in compliance with ISO 9001:2000, process objectives must be listed. For example, if we take the construction process done in section 4.3, some objectives must be defined and audited upon. These objectives are related to the percentage of test cases passed and failed during the verification of the developer checklist. Another objective is related to percentage of correctly fixed bugs in a release. And a final objective should be related to the ratio of number of Fixes over the estimated working days of architecture per module. These objectives' percentages and ratio should be presented in number. Estimating those numbers cannot be done accurately without analyzing previous data to identify the capacity of employee and old system. The study could stated any reasonable numbers- like 80% of the listed test cases in the Developer Testing checklist should pass, 80% of the verified reported bugs should be fixed correctly and the ratio of number of fixes over estimated working days of architecture per module should be less that 0.1- but these numbers estimates are not based on real data and could largely vary when the company starts operating by the new quality system. The analysis is therefore limited on the design of the process and without going into each process objective numbers.

Some other barriers, which have minor impacts on the study, were also noticed, like delaying the study for 2 months because the staff was fully concentrated on a software project to be delivered to Saudi Arabia. Consequently, no time was available for the meetings dealing with the project.

5.2 Recommendations

After working with almost all head of departments on the study, one can notice a young professional team striving to improve its skills but needs a unified road to move on. SecurSoftware is a promising firm employing 37 people with an average age of 27. This means that all potentials are at hand but needs to be trained, motivated and rewarded. The first and obvious recommendation is to move on in restructuring the old system because it starts loosing. Beside the risks that may influence any future plans, SecurSoftware can easily find alternatives knowing that its main markets are becoming outside Lebanon. The recommendations for SecurSoftware if the implementation plan is applied are as follows:

I. Quality Control Department

There are 3 test engineers in the quality department holding a bachelor degree in computer science. Knowing that testing is not only a part of Computer Science, these software testing engineers must be trained to be more effective in their software testing process.

1. ***Software Testing Training Courses***

   It is recommended to SecurSoftware as a first step to register its quality department employees in "software testing certification" training courses. Through these courses, they learn the basics needed to become a software test and quality assurance professional and understand how testing fits into the software development lifecycle. There are multiple institutions that offer such trainings. SecurSoftware can contact International Software Testing Qualifications Board known as ISTQB or Software Quality Engineering known as SQE. These 2 institutions are internationally known and can send the training packages online. E-Learning is the perfect solution for software professionals with travel and time constraints, this way the employees can be trained from their own desktop with 24/7 access on the web.

2. *Software Testing Certification*

After completing the training courses, it is recommended to SecurSoftware to assess the testing capability of its quality assurance department employees by requiring them to pass the certification test offered by the institutions listed above. The certification will add value to the employee's career and to the company where new techniques are used in testing its application.

3. *Testing Software Tools*

Knowing that the company test engineers are doing all the application testing manually, it is recommended to SecurSoftware to use software testing tools when needed, in order to improve the testing process. The automation tools will be, at first use, complicated for the test engineers and take time to be accomplished. However, with experience, software test tools help a lot in identifying bugs. It is recommended for the test manager to analyse the cost and benefits of integrating testing tools before doing the testing of any application and identify the kind of automation tools needed. Sometimes the automation test is costly and without being that useful for the application. It is up to the test manager and project manager to decide whether the application needs extra testing push or not.

II. Technical Department

1. ***Participation in writing the ISO required documents templates***

It is recommended to SecurSoftware to ask employees working in the technical department to participate in the ISO required documents templates which are the business plan and the software architecture. Each one of them must write down what should be included in these templates and why. This way, the documentation required by ISO is faster and easier to handle.

2. ***More communication in the new inception phase process***

It is recommended to the project manager who plays the biggest role in the new inception phase process (see figure 9) to communicate the important application points to the entire team, the one responsible for the development of the new software. Meetings discussing the new application requirements and main functions are suggested to be done frequently before moving to the construction phase. SecurSoftware should sacrifice more time in this phase fully explaining

all user requirements. The more the team is familiar with the application the less critical errors are identified in the next two phases, therefore costs are reduced.

3. ***Coding checklist***

   Writing clear, high quality, maintainable requires a certain amount of discipline. Coding standards outline rules about the way code should be written and recommend also standard way to layout code or name classes or variables to make code more reliable and better performing. This way, developers are trained to preserve good coding habits.

III. The Management

The management plays the biggest role in the success of the implementation of any quality management system. What this study recommends to the management in order to preserve such structure is as follows:

1. ***Commitment at all levels:***

   It is recommended to SecurSoftware top management and middle management to demonstrate commitment by word and action at all levels. It is recommended to start by participating in training of employees to demonstrate commitment. The management should make ISO certification and regular business of equal importance because both are critical to organizational success. Moreover, they should make ISO contributions a part of employees' performance objectives; Evaluation criterion is therefore, a good way to do this.

2. ***Effective internal audits and corrective action follow-up***

   It is recommended to SecurSoftware to guarantee experienced auditors to perform periodic assessment and internal auditor support. Furthermore, the company must offer audit familiarization training to large numbers of potential internal auditor candidates (candidate will be selected from the company employees). This helps in the selection of better internal auditors and educates more personnel on the positive aspects of auditing.

3. ***Strong implementation organization***

   It is recommended to SecurSoftware to empower the implementation team with the necessary training, resources, coordination and communications early in the process. The company should choose personnel who can work together effectively and willingly.

4. ***Well-organized required ISO documentation***

It is recommended to SecurSoftware to keep the document control system simple and make flexible work instructions so that training employees on new documents becomes fast and easy to understand. Beside, the quality policy should be simple and direct as well as communicated to all employees.

5. ***ISO training***

It is recommended to SecurSoftware to adequate training to all employees including middle management before launching the new quality management system. Employees simply cannot be expected to accomplish what they are not trained to do.

6. ***Preserving ISO Certification***

It is recommended to SecurSoftware in order to maintain the ISO certification and more importantly its quality management system efficient the following actions:

- Frequent management reviews to intensify awareness and set priorities as the certification maintenance audit approaches.
- Creating a system for customer satisfaction feedback and complaints (it can be listed online).
- Frequent internal audits followed by corrective actions when needed.
- Assessing product quality by comparing objectives and real obtained numbers for each process.
- Quantifying and tracking financial advantages then recognizing employee contributions with awards or bonuses.

All the above recommendations are the key success to implement and preserve a quality management system.

Quality is an essential attribute in software. To ensure quality, the organization must use process-based methods and incorporate efficient measures in these processes. As this study demonstrates, the new structure of ISO 9001:2000 is a process-based structure. It requires a solid measurement program. The Quality objectives should be measurable, the measurement and monitoring activities should be defined and planned, the customer satisfaction, processes and product should be monitored and measured and data collected from the measurements should be used aiming towards improvement. All what the top management needs to focus on is

how to create an environment of commitment towards achieving quality and continual improvement. ISO 9001:2000, if applied, will put the company on the right road toward achieving excellence.

However, the company needs, after implementing ISO, a model for process improvement. The Capability Maturity Model Integration known as CMMI is the answer. If an ISO-certified organization wishes to improve its processes continuously, implementing CMMI would be a profitable choice knowing that it offers a model for judging the software processes of an organization and for identifying key practices required to increase the maturity of these processes.

The CMM model was designed with five levels of maturity, ISO does not have them. CMM level 5 is the ultimate level. Every time an organization steps to the next maturity level, it means that it is achieving better project performance and producing higher quality products.

What SecurSoftware can benefit from CMMI is the following:

- CMM was designed to ensure bug-free development
- Decrease of the cost of the processes employed to produce the products (decrease in the average cost to fix a defect, reduction in unit software costs, decrease in defect find and fix costs, cost variances decreased as process maturity increased.)
- Improvements in schedule predictability and reductions in the time required to do the work.
- Quality improvement: quality of code, reduction in number and severity of post-release defects
- Increase the return on investment

But the problem remains in balancing ISO and CMM against the business model. First, it is not easy to identify any reusable parts of the ISO standards, and would be advantageous to be able to reuse selected portions of the ISO standards during CMMI adoption in order to use existing resources to their best advantage. Second, it is difficult for an ISO-certified organization to implement CMMI in a straightforward, easy manner because of the differences in the language, structure, and details of the two sets of documents.

A unified model for ISO 9001:2000 and CMMI that resolves these two issues, ask for a detailed study. The research would be an extremely useful tool for ISO-certified organizations that plan to implement CMMI.

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APPENDICES

Appendix A
History of ISO 9000

Pre ISO 9000

During WWII, there were quality problems in many British high-tech industries such as munitions, where bombs were exploding in factories during assembly. The adopted solution was to require factories to document their manufacturing procedures and to prove by record-keeping that the procedures were being followed. The name of the standard was BS 5750, and it was known as a management standard because it did not specify what to manufacture, but how to manage the manufacturing process. According to Seddon, "In 1987, the British Government persuaded the International Organisation for Standardization to adopt BS 5750 as an international standard. BS 5750 became ISO 9000."

1987 Version

ISO 9000:1987 had the same structure as the UK Standard BS 5750, with three 'models' for quality management systems, the selection of which was based on the scope of activities of the organization:

- ISO 9001:1987 Model for quality assurance in design, development, production, installation, and servicing was for companies and organizations whose activities included the creation of new products.
- ISO 9002:1987 Model for quality assurance in production, installation, and servicing had basically the same material as ISO 9001 but without covering the creation of new products.
- ISO 9003:1987 Model for quality assurance in final inspection and test covered only the final inspection of finished product, with no concern for how the product was produced.
- ISO 9000:1987 was also influenced by existing U.S. and other Defence Standards ("MIL SPECS"), and so was well-suited to manufacturing. The emphasis tended to be placed on conformance with procedures rather than the overall process of management — which was likely the actual intent

1994 version

ISO 9000:1994 emphasized quality assurance via preventative actions, instead of just checking final product, and continued to require evidence of compliance with documented procedures. As with the first edition, the down-side was that companies tended to implement its requirements by creating shelf-loads of procedure manuals, and becoming burdened with an ISO bureaucracy. In some companies, adapting and improving processes could actually be impeded by the quality system

2000 version

ISO 9001:2000 combines the three standards 9001, 9002, and 9003 into one, now called 9001. Design and development procedures are required only if a company does in fact engage in the creation of new products. The 2000 version sought to make a radical change in thinking by actually placing the concept of process management front and centre. ("Process management" was the monitoring and optimizing of a company's tasks and activities, instead of just inspecting the final product.) The 2000 version also demands involvement by upper executives, in order to integrate quality into the business system and avoid delegation of quality functions to junior administrators. Another goal is to improve effectiveness via process performance metrics — numerical measurement of the effectiveness of tasks and activities. Expectations of continual process improvement and tracking customer satisfaction were made explicit.

Appendix B

Project Plan Sample

Project Goals	
Start Date	
Target Registration Date	
Responsibilities	
Project Manager	
Management Representative	
Top Management	
ISO 9001:2000 Steering Team	

Project timeline		
Step	**Schedule Date**	**Completion Date**
Project manager online Training		
Steering team identification		
Gap analysis		
Task team identification		
QMS documentation		
Implementation		
Internal quality audit		
Management review		
Pre-assessment audit		
Certification and Registration		

Appendix C

Gap Analysis Checklist

There are three possible answers to the gap analysis questions:

Yes – means the department/division has already met the ISO's requirement and the auditor can provide evidence to support the response.

No – reveals gaps existing between the ISO 9001:2000 standard and the department/division's management system. When the answer is No this means that the auditor needs to take a look at the requirement in question and initiate an action to create, modify, or improve the management system in such a manner as to change the No to Yes.

An *N/A* answer says the question is not applicable in the situation.

ISO clauses	**Questions**	**Status**
4.1 Management Responsibility	1. Have you identified procedures, their sequence and relations within the management system?	
	2. Have you established criteria to ensure operation and control of procedures?	
	3. Have you organized operations in such a way that the department/division is consistently providing services and/or products which meet customer's requirements?	
	4. Do you ensure availability of resources and information in support of the procedures?	
	5. Do you monitor and measure procedures?	
	6. Do you implement action plans to achieve desired results of management system procedures?	
	7. Do you document procedures and needed records supporting the management system?	
	8. Do you apply the process approach (Plan-Do-Check-Act) to achieve effective and efficient control of procedures, resulting in continual improvement?	
	9. Do you continually work with staff at all levels to improve the effectiveness of the department/division's management system?	
4.2 Documentation	10. Have you identified and documented procedures that must be highly organized, consistent and predictable, and are needed to meet customer requirements?	

	11. As part of your documented procedures have you included: ▪ Purpose ▪ Title or titles of the individual(s) responsible for overseeing the steps of the process ▪ Process input needed to fulfill the requirements of the customer ▪ Definitions of used terms ▪ Process Description ▪ Supporting document references used in the procedure, ▪ A record retention table defining how records are identified, stored, retained, protected ▪ A document revision history stating the date of change, document revision number and a brief description of the revision ▪ A process output statement briefly identifying the expected output of processes ▪ The required approval from department/ division leadership.	
	12. Can you provide documents and records used to support effective and efficient operation of the procedures for your department?	
	13. Are internal and external documents required by your department/division identifiable and controlled?	
	14. Is there a procedure established to define the controls needed to: Approve documents prior to issue? ▪ Review and update documents as necessary and to re-approve? ▪ Ensure changes and current revision status are identified? ▪ Ensure relevant and applicable document versions are available at points of use? ▪ Ensure documents remain legible and readily identifiable? ▪ Ensure documents of external origin are identified and their distribution controlled? ▪ Prevent unintended use of obsolete documents?	
	15. Have you reviewed the CCSD Management Process System manual?	
	16. Is your staff aware of the CCSD Management Process System manual and where it is located?	
5.1 Management Responsibility	1. Do you demonstrate leadership, commitment and involvement in promoting quality?	
	2. Do you communicate to your department/division the importance of meeting customer as well as statutory and regulatory requirements?	
	3. Have you ensured the establishment of measurable objectives?	
	4. Do you conduct regular staff meetings with employees in which you discuss issues concerning: measurable objectives, customer requirements, customer feedback, continuous improvement, etc. and are these meetings recorded (meeting minutes)?	
	5. Do you ensure the availability of resources within your department/division?	
5.2 Needs and Expectations of Interested Parties	6. Have you identified your department/division's customers?	
	7. Have you ensured everyone in your department/division knows who their customers are?	
	8. Are the needs and explanations of other interested parties identified, which may effect your customer's requirements?	
	9. Do you ensure customer requirements are determined and met with the goal of enhancing customer satisfaction?	
	10. Do you have evidence of meeting those requirements?	
	11. Does your department/division meet customer requirements?	
	12. How do you communicate with your department/division's customers to ensure their requirements are being met?	
5.3 Quality policy and	13. Have you established a mission statement for your department/division with staff collaboration?	

Mission statement	14. Have you taken steps to communicate your mission statement to your department/division personnel ensuring all personnel know and understand the mission statement?	
	15. Do you take steps to communicate the CCSD quality statement to your department/division staff ensuring all staff know and can articulate the quality statement?	
5.4 Planning	16. Do you ensure measurable objectives are formulated and input is sought at all levels of the department/division?	
	17. Are the measurable objectives communicated to each staff level ensuring individual contribution to achievement?	
	18. Do you ensure the availability of resources needed to meet measurable objectives?	
	19. Do you take steps to ensure department/division personnel know where measurable objectives, written procedures, work instructions, and checklists can be found?	
	20. Do you ensure appropriate department/division personnel participate in and are knowledgeable of changes to the department/division measurable objectives?	
5.5 Responsibility, Authority and Communication	21. Do you ensure responsibilities and authorities are defined, established, and communicated to all staff in your department/division?	
	22. Do you communicate customer requirements, measurable objectives and accomplishments contributing to the improvement of the department/ division's performance?	
	23. Have you provided a current department/division organizational chart to all personnel in the department/ division, or do all personnel know where the most current organizational chart can be found?	
	24. Do you communicate to department/division personnel how the mission of your department/division impacts a child's education?	
	25. Do you and your staff know who the CCSD MPS management representative is?	
	26. Do you facilitate and ensure communication throughout your entire department/division?	
	27. Have you established an internal communication processes? (i.e. newsletter, meeting minutes, electronic recordings, etc.)	
	28. Do you encourage suggestions from your staff which could lead to the improvement of your department/ division?	
	29. Do you ensure your department/division's management system is routinely discussed?	
5.6 Management Review	30. Do you review your department/division's management system at planned intervals to ensure its continuing suitability, adequacy, and effectiveness?	
	31. Does this review include assessing opportunities for improvement and the need to improve your system?	
	32. Do you ensure valid information and input by staff is available for CCSD management review team meetings?	
	33. Do you review and communicate: ▪ Results of audits? ▪ Customer feedback? ▪ Process performance and service product conformity? ▪ Status of preventive and corrective action? ▪ Follow-up actions from previous reviews? ▪ Changes affecting your management system? ▪ Recommendations for improvement?	

	34. Does the output of the management review include: ▪ Improvement of the effectiveness of the management process system and its procedures? ▪ Improvement of service/product related to customer requirements? ▪ Resource needs?	
6.1 Resource Management – General Guidance	1. Have you identified and provided the resources needed to meet your customer requirements?	
	2. Have you made a comparison of your department to other districts or similar industries concerning best practices?	
	3. When you discover you do not have adequate resources needed to meet customer requirements, do you inform leadership?	
6.2 People	4. Do you study the retention rate of employees within your department?	
	5. Have you established and implemented an orientation process for providing new employees information needed to ensure familiarity with the requirements of your department/division?	
	6. Do you have a contingency plan in the event your department/division should lose someone in a critical position?	
	7. Do you promote involvement of people for improvement of the effectiveness and efficiency of your department/division?	
	8. Do you ensure the competency of people in the department/division is adequate for current and future needs?	
	9. Do you identify people's need for recognition, work satisfaction, competence, and personal development?	
	10. Do you: ▪ Provide training or other actions to satisfy training needs? ▪ Evaluate the effectiveness of the actions taken relative to personnel training? ▪ Ensure personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of measurable objectives? ▪ Maintain appropriate records of education, training, skills and experience? ▪ Ensure all department/division personnel have received CCSD MPS training?	
6.3 Infrastructure	11. Do you ensure the infrastructure is appropriate for the achievement of the objectives of the department/ division?	
	12. Do you consider environmental issues associated with the infrastructure?	
	13. To ensure conformity to customer requirements, does your department/division: ▪ Provide buildings, workspace and associated utilities needed to achieve conformity? ▪ Provide the necessary processing equipment? ▪ Provide the necessary support services?	
6.4 Work Environment	14. Have you identified the work environment which is needed to ensure customer requirements are met?	
	15. Do you ensure the work environment promotes positive morale, motivation, satisfaction, development, quality performance, and continuous improvement of people in your department/division?	

	16. Have you ensured the elimination of: ▪ Neglected libraries of laws, regulations, outdated standards, and software? ▪ Dust, dirt and accumulation of trash? ▪ Overcrowded work areas, and unsuitable working conditions? ▪ Stacks of documents waiting to be filed and/or processed? Chaotic arrangements of production flow, intermingling of unrelated operations in the same area? ▪ Improper storage of materials and/or components and supplies in unauthorized "free spaces" around the service or production areas? ▪ Inadequate separation of storage areas from production areas?	
	17. Does your department/division have a documented data disaster response plan?	
	18. Have you communicated your department/division's data disaster response plan to all appropriate staff members?	
	19. Have you ensured all appropriate staff members know where to find your department/division's data disaster response plan?	
	20. Do you routinely check your department/division's disaster response plan to ensure suitability?	
	21. Does your department/division routinely backup data?	
	22. Are data backups appropriately stored separate from data system?	
	23. Are data backups controlled by identification number and their movement tracked and logged?	
	24. Do you assure proper assignment and management of passwords concerning critical systems data access?	
	25. Do you plan, provide, control and monitor the financial resources necessary to ensure the achievement of the objectives of your department/ division?	
	26. Do you take steps to determine cost savings and cost avoidance within your department/division?	
7.1 Control of Operations	1. In developing **new** products or services do you determine the following, as appropriate: ▪ Measurable objectives or requirements for the product/service. ▪ The establishment of procedures, documents, and needed resources specific to the product or service. ▪ Required verification, validation, monitoring, inspection, and test activities specific to the product/service, and the criteria for product/ service acceptance. ▪ Records needed to provide evidence that the product/service development process and resulting product/service meet requirements of the organizations management system.	

	2. As part of your documented procedures concerning the development of **new** products/services have you included: ▪ Title or titles of the individual(s) responsible for overseeing the steps of the process? ▪ Process input needed to fulfill the requirements of the customer? (i.e. resources see section 6) ▪ Definitions such as acronyms and noncommonly used terms? ▪ Process Description? ▪ Supporting document references used in the procedure? ▪ A record retention table defining how records are identified, stored, retained, disposed of and protected? ▪ A document revision history stating the date of change, document revision number and a brief description of the revision? ▪ A process output statement briefly identifying the expected output of the process? ▪ Any work instructions, process maps and/or checklists? (optional) ▪ The required approval from department/ division leadership? ▪ A document control number which has been approved by the CCSD MPS Office?	
	3. Have you ensured appropriate personnel within the department/division are aware and familiar with documented procedures?	
	4. Do all individuals within the department/division know where to find documented departmental procedures? Are all individuals informed when procedures change	
7.2 Control Customer Processes	5. Are all individuals informed when procedures change?	
	6. Have you determined your customer's requirements for pre and post delivery of products/services?	
	7. Have you determined the requirements not stated, but necessary for specific or intended use, where known?	
	8. Have you determined statutory and regulatory requirements related to the customer requirements?	
	9. Have you determined additional CCSD mandated requirements?	
	10. Does your department/division review service/product requirements before it agrees to provide services/ products to customers?	
	11. Do you determine and communicate if your department/division has the ability to meet the defined requirements?	
	12. Do you review requirements before you submit a purchase order?	
	13. Do you review requirements before you accept a contract?	
	14. Do you review requirements before accepting contract changes?	
	15. Do you review requirements before accepting an order?	
	16. Do you review requirements before accepting change orders?	
	17. Do you verify service/product requirements are specified before you agree to supply services/products to customers?	
	18. Do you confirm the accuracy of unwritten orders before you agree to supply services/products to customers?	
	19. Do you resolve differences between the quote and the final order before you agree to accept or supply services/ products?	
	20. Do you confirm the accuracy of service/product advertisements and catalogs?	
	21. Do you communicate changes in the customer's requirements to all relevant personnel?	

	22. Do you determine and implement arrangements for communicating with customers with regard to: ▪ Service/product information? ▪ Inquires, contracts or order handling? ▪ Customer feedback, including customer complaints?	
	23. Do you document customer feedback, including customer complaints?	
	24. Do you make data driven decisions based on customer feedback, including customer complaints?	
	25. Can you provide evidence that action taken concerning customer feedback has had a positive impact on the department/division?	
	26. Do you provide customer feedback data to district leadership to assist them with data driven decisions?	
7.3 Control Service/Product Development	27. When planning your department/division's service/ products do you write down what you plan to do?	
	28. When planning your department/division's service/products do you examine ▪ Customer requirements concerning the service/product? ▪ Requirements that are imposed by external agencies? ▪ The service/product regulatory and statutory requirements? ▪ Best practices or similar designs concerning the product/service? ▪ Needed input concerning the service/product? ▪ The required output of the service/product?	
	29. During planning do you take into consideration measurable objectives concerning the service/product?	
	30. Do you encourage interaction between groups who participate in the planning and development process?	
	31. Do you ensure planning and development groups communicate?	
	32. Do you ensure that individual/team responsibilities and authorities are clearly defined?	
	33. Do you ensure you are doing what you wrote down?	
	34. Do you identify problems during testing or implementation phases?	
	35. Do you propose and document follow-up actions and solutions to address problems?	
	36. Do you ensure that representatives from relevant areas are involved in the service/product plan and development implementation process?	
	37. Can you provide sufficient evidence to support the fact that you are doing what you wrote down?	
	38. Do you assess how well results are meeting customer requirements and measurable objectives?	
	39. Do you communicate results to leadership?	
	40. Do you review, revise, and correct service/products to ensure continuous improvement by; ▪ Identifying changes in service/product design and development? ▪ Examining feedback from staff and customers? ▪ Documenting and communicating changes and improvements? ▪ Identifying, documenting and communicating areas of cost savings and cost avoidance?	
7.4 Control Purchasing Function	41. Have you defined purchasing processes ensuring purchased products satisfy the department/division needs?	
	42. Does your department/division evaluate and select suppliers based on their ability to supply services/ products in accordance with CCSD purchasing requirements?	

	43. When purchasing products or services do you take into consideration: ▪ Requirements for approval? ▪ Needed procedures, processes, and additional resources? ▪ Requirements for qualification of personnel? ▪ Quality management system requirements? ▪ The adequacy of specified purchase requirements prior to their communication to the supplier?	
	44. Does the purchasing information describe the product in sufficient detail?	
	45. Have you established and implemented inspection or other activities necessary for ensuring purchased service/products meets specified purchase requirements?	
	46. Do you plan and carry out service and production under controlled conditions, including: ▪ The availability of information describing the characteristics of the service/product? ▪ The availability of work instructions, as necessary? ▪ The use of suitable equipment? ▪ The availability and use of monitoring and measuring equipment? ▪ The implementation of monitoring and measurement equipment? ▪ The implementation of release, delivery and post-delivery activities?	
	47. Do you validate procedures for service and production provisions when you cannot check the service/product?	
	48. Does the validation demonstrate the ability of these procedures to achieve planned results?	
	49. Have you established arrangements for these procedures, as applicable: ▪ Defined criteria for review and approval? ▪ Approval of equipment and qualification of personnel? ▪ Use of specific methods and procedures? ▪ Requirements for records? ▪ Revalidation?	
	50. Is the service/product identified by suitable means throughout the service production process (where appropriate)?	
	51. Do you identify the service/product status with respect to monitoring and measurement requirements?	
	52. Where traceability is a requirement, does the organization control and record the unique identification of the service/ product?	
	53. Do you identify, verify, protect, and safeguard customer property provided for use or incorporation into the service/product?	
	54. If any customer property is lost, damaged, or otherwise found to be unsuitable for use, is this reported to the customer and are records maintained?	
	55. Does the preservation include identification, handling, packaging, storage and protection?	
7.6 Control Monitoring Devices	56. Have you identified measuring and monitoring requirements?	
	57. Have you identified the necessary monitoring to ensure your service/product meets specified requirements?	
	58. Have you identified the measurements that should be done to ensure that your service/products meet specified requirements?	

	59. Where necessary to validate results, is the measuring equipment: ▪ Calibrated or verified at specified intervals, or prior to use, against measurement standards traceable to international or national standards? ▪ Where no such standard exists, is the basis used for calibration or verification recorded? ▪ Adjusted or re-adjusted as necessary? ▪ Identified to enable the calibration status to be determined? ▪ Safeguarded from adjustments invalidating the measurement result? ▪ Protected from damage and deterioration during handling, ▪ Maintenance and storage?	
	60. Do you assess and record the validity of the previous measuring results when the equipment is found not to conform to requirements?	
	61. Are records of the results of calibration and verification maintained?	
	62. When used, is the ability of computer software to satisfy the intended application confirmed prior to use and reconfirmed as necessary?	
8.1 Perform Remedial Processes	1. Has your department/division planned and implemented the monitoring, measurement, analysis, and improvement processes needed to: ▪ Demonstrate conformity of the customer requirements? ▪ Ensure conformity of the management system? ▪ Continually improve the effectiveness of the management system? ▪ Ensures effective and efficient measurement, collection and validation of data for improvement.	
8.2 Monitor and Measure Quality	2. Have the methods for obtaining and using customer satisfaction information been determined?	
	3. Does your department/division monitor, collect, and analyze information relating to customer satisfaction as to whether customer requirements	
	4. Does CCSD conduct process audits of your department/ division at planned intervals?	
	5. Do the audits determine whether the management system: ▪ Conforms to the planned arrangements of requirements established by the CCSD management system. ▪ Is effectively implemented and maintained?	
	6. Is the audit program planned, taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits?	
	7. Are the audit criteria, scope, frequency and methods defined?	
	8. Do the selection of auditors and the manner in which audits are carried out ensure the objectivity and impartiality of the audit process?	
	9. Do you ensure actions are taken in a timely manner to eliminate detected nonconformities and their causes?	
	10. Do follow-up activities include the verification of the actions taken and the reporting of verification results?	
8.3 Control non Conforming Product	11. Have you developed a process to identify and prevent the unintended use or delivery of a service/product which does not meet customer requirements?	
	12. Do you have a procedure which defines the controls, related responsibilities and authorities for dealing with nonconforming service/product?	
	13. Have you ensured all department/division personnel are informed of the CCSD Process Corrective Action (PCA) program?	

	14. Does your department/division deal with nonconforming service/products by one or more of the following ways: ▪ By taking action to eliminate the detected nonconformity? ▪ By authorizing its use, release or acceptance under concession by a relevant authority and, where applicable, by the customer? ▪ By taking action to preclude its original intended use or application?	
	15. Is a nonconforming service/product re-verified to demonstrate conformity to the customer's requirements?	
	16. When a nonconforming service/product is detected after delivery and use has started, do you take action appropriate to the effects, or potential effects of the nonconformity?	
	17. Are records of the nature of nonconformities and any subsequent actions taken, including concessions obtained, and maintained?	
8.4 Analyze data	18. Does your department/division determine, collect and analyze appropriate data to demonstrate the suitability and effectiveness of the management system? Does it evaluate the continued improvement of effectiveness within the management system?	
	19. Does the analysis of data provide information relating to: ▪ Customer satisfaction? ▪ Conformity to service/product requirements? ▪ Characteristics and trends of processes and services/products including opportunities for preventive actions? ▪ Suppliers?	
	20. Does your department/division continually improve the effectiveness of the management system through the use of the quality policy, measurable objectives, audit results, documented procedures, and analysis of data, preventive and corrective actions?	
	21. Do you ensure the use of systematic improvement methods and tools to improve your department/ division's performance?	
	22. Does your department/division take action to eliminate the cause of nonconformities in order to prevent reoccurrence?	
	23. Does the department/division have a procedure to define the requirements for: ▪ Reviewing nonconformities (including customer complaints)? ▪ Determining causes of nonconformities? ▪ Evaluating the need for action to ensure nonconformities do not recur? ▪ Determining and implementing action needed? ▪ Records of results of action taken? ▪ Reviewing corrective action taken?	
	24. Does your department/division determine the action to eliminate the causes of potential nonconformities in order to prevent their reoccurrence?	
	25. Does the department/division have a procedure to define the requirements for: ▪ Determining the potential nonconformities and their causes? ▪ Evaluating the need for action to prevent occurrence of nonconformities? ▪ Determining and implementing action needed? ▪ Records of results of action taken? ▪ Reviewing preventive action taken?	

Appendix D

Quality Manual

Quality manual definition

It is a document containing the quality policy, quality objectives, structure chart, and description of the quality system of an organization. It often explains how the requirements of a quality standard are to be met and identifies the person responsible for quality management functions.

Quality Manual: Table of contents

Appendix E

The last 6 implementation steps of ISO 9001:2000

Step 7: Implementation

It is good practice to implement the quality management system (QMS) being documented as the documentation is developed, although this may be more effective in larger firms. In smaller companies like SecurSoftware, the QMS is often implemented all at once throughout the organization.

The implementation progress should be monitored to ensure that the QMS is effective and conforms to the standard. These activities include internal quality audit, formal corrective action and management review.

Step 8: Internal Quality Audit

As the system is being installed, its effectiveness should be checked by regular internal quality audits. Internal quality audits are conducted to verify that the installed QMS:

- Conform to the planned arrangements, to the requirements of the standard (ISO

9001:2000) and to the QMS requirements established by the organization

- Is effectively implemented and maintained.

Even after the system stabilizes and starts functioning, internal audits should be planned and performed as part of an ongoing strategy.

A few staff members should be trained to carry out internal auditing.

Step 9: Management Review

When the installed QMS has been operating for three to six months, an internal audit and management review should be conducted and corrective actions implemented. The management reviews are conducted to ensure the continuing suitability, adequacy and effectiveness of the quality management system.

The review should include assessing opportunities for improvement and the need for changes to the QMS, including the quality policy and quality objectives.

The input to management review should include information on:

- Results of audits
- Customer feed back
- Process performance and product conformity
- Status of preventive and corrective actions
- Follow-up actions from previous management reviews
- Changes that could affect the quality management system
- Recommendations for improvements

Step 10: Pre-assessment Audit

When system deficiencies are no longer visible, it is normally time to apply for certification. However, before doing so, a pre-assessment audit should be arranged with an independent and qualified auditor. Sometimes certification bodies provide this service for a nominal charge. The pre-assessment audit would provide a degree of confidence for formally going ahead with an application for certification.

Step 11: Certification and Registration

Once the QMS has been in operation for a few months and has stabilized, a formal application for certification could be made to a selected certification agency. The certification agency first carries out an audit of the documents (referred to as an "adequacy audit"). If the documents conform to the requirements of the quality standard, then on-site audit is carried out. If the certification body finds the system to be working satisfactorily, it awards the organization a certificate, generally for a period of three years. During this three-year period, it will carry out periodic surveillance audits to ensure that the system is continuing to operate satisfactorily.

Appendix F
Documents Templates

I. Business Development Plan Content

Purpose of BDP

1. To understand the structure and the dynamics of the organization in which a system is to be deployed (the target organization).
2. To understand current problems in the target organization and identify improvement potentials
3. To ensure that customers, end users and developers have a common understanding of the target organization
4. To derive the system requirements needed to support the target organization.
5. To achieve these goals, you need to develop a vision of the new target organization, and based on this vision define the processes, roles, and responsibilities of that organization in a business use-case mode

Content of BDP

1. Vision Statement
2. Problem Statement
3. Business Requirements
   - Data Accuracy
   - Enhanced Productivity
   - lower Cost of Operation
   - Improved Performance, Security, and Reliability
4. Solution Concept
   - Current Scenario
   - Future Scenario
5. Major Features in the project
6. Project Scope
   - Scope of Initial and Subsequent Releases
7. Statement of Work
   - Coverage of Data Availability
   - Integration of Available Data
   - Speed of Access
   - Data Accuracy
   - Reports/Analysis
8. The services provided:
   - Planning Services
   - Development Services
   - Program Management Services
9. Data requirements
   - Sources of Data
   - Location of the Data
   - Data Ownership and Management
   - Data Quality
10. Deliverables (items that should be delivered to the client)
11. Limitations and Exclusions

- Product features or characteristics that a stakeholder might anticipate, but which are not planned to be included in the new product

12. Success Factors
    - Dependencies
    - Risks
    - Assumptions
13. Project Plan
    - Methodology
    - Work Breakdown Structure
14. Solution Support
15. Hardware and Software recommendations
16. Cost Analysis
17. Estimated Development Fees Breakdown

Resource Description	Days
PM	
Sr. Architect	
Developer	
Quality Engineer	
System Administrator	
Database Administrator	
Sr. Systems Analyst	
Systems Analyst	
Graphic Designer	
Total (person's days)	
Total Cost	

18. Delivery Schedule

Deliverables	Expected date of deployment
Module 1	
Module 2	
Module n-1	
Module n	
Deployment Unit	

19. Use Case Identification
    - Definition of use case and what is containing

II. Test Plan Content

Overview

Introduction of the overall project

Objective

What the company strive to accomplish, taking the following factors into account: quality, schedule, and cost.

Testing outline

1 **Test Items:** Deliverable products or applications to be tested (software and publishing items)

2 **Features list to be tested:** The list may include the environment to be tested under.

3 **Features list Not to be Tested:** List of features that will not be covered in this test plan

4 **Testing Approach:** For each major group of features or feature combinations, specify the types of tests required, e.g., Regression, Stress tests, Compatibility, Conformance, Functional, Load, Performance, smoke tests, User Interface tests, etc. Specify the major activities, techniques, and tools which are used to test the designated features.

5 **Test Phases:** Identify test phases, such as unit, integration, and system testing. For each phase, address the topics described below:

- ***Definition:*** Provide a brief description of the process (scenario) involved in performing the activities in the phase.
- ***Participants:*** Identify the person or group responsible for conducting this test phase. Describe the expected level of involvement of the project team, test group, and any other functional areas.
- ***Sources of Data*:** Provide a more detailed description of the source and type of data for this test phase.
- ***Work Products:*** Describe the work products which are initiated and/or completed in this phase, including test documents and reports.
- ***Test Completion Acceptance:*** Describe the criteria for acceptance of the completion of the test results. When is the test complete?

6. **System Requirements:**

- **Server Hardware and Software Configuration requirements:** List all Hardware and Software requirements needed for this test to be done:
- **Clients Requirements:** List Client requirements for this test:
- **Database Support:** list the database we are using

7. **Test Deliverables:** List of test materials developed by the test group during the test cycle to be delivered upon the completion of this project. All test plans (original, executed) and the bug tracking system (summary list of all bugs found)

Testing Project Management

1. **The Product Team:** List of product team members and their roles

2. **Testing Tasks:**

- Develop Test Plan including test cases, schedule, etc.

- Conduct test-plan reviews and obtain appropriate approvals.
- Obtain hardware / Software / Tools required.
- Create Bug Database
- Perform Tests.
- Report Bugs

3. **Test Schedule and Resource:** List of task groups and the preliminary schedule matched with resource needs and test tasks.
4. **Training Needs:** Identify training needs
5. **Risks & Contingencies:** Risks and possible adjustments to the plan

III. Global Software Architecture Content

1. **Introduction:** it should provide an overview of the entire Software Architecture Document. It should include the purpose, scope, definitions, acronyms, abbreviations, and references.

2. **Architectural Goals and Constraints:** This section describes the software requirements and objectives that have some significant impact on the architecture, for example, safety, security, privacy, use of an off-the-shelf product, portability, distribution, and reuse. It also captures the special constraints that may apply: design and implementation strategy, development tools, team structure, schedule, legacy code, and so on.

3. **Global Sequence Diagram:** This section shows the interaction between all use cases in the project. The main objective is to display the sequence of events from beginning till end of the project.

4. **Use-Case View:** This section lists use cases or scenarios from the use-case model if they represent some significant, central functionality of the final system.

5. **Logical View:** This section describes the architecturally significant parts of the design model, such as its decomposition into subsystems and packages, and for each significant package, its decomposition into classes and class utilities. You should introduce architecturally significant classes and describe their responsibilities, as well as a few very important relationships, operations, and attribute

6. **Deployment View:** This section describes one or more physical network (hardware) configurations on which the software is deployed and run.

7. **Implementation View:** This section describes the overall structure of the implementation model, the decomposition of the software into layers and subsystems in the implementation model, and any architecturally significant components.

8. **Size and Performance:** This section provides a description of the major dimensioning characteristics of the software that impact the architecture, as well as the target performance constraints

9. **Quality:** A description of how the software architecture contributes to all capabilities (other than functionality) of the system: extensibility, reliability, portability, and so on. If these characteristics have special significance, for example safety, security or privacy implications, they should be clearly delineated.

IV. Detailed Software Architecture Content

This document includes architectures for all modules, and sub-modules for the system being developed. There is no limit for sub-modules levels and this is left to the discretion of the software architects.
By definition, a module or sub-module is to be submitted to a **team leader** or to a **developer** for implementation. Each module should have its own architecture section which should be self-explanatory on its own without the need to read the whole architecture document.

The section for each module or sub-module might contain:

1. Description : Brief Description of the module or sub-module for the developer to understand what his module will be used for

2. Implementation Model: Description of what u expect from the developer to deliver for this specific module. It can be documentation, source code, and/or executable

3. Data Model:
   - Diagram showing relationships between tables,
   - Description of each table

4. Design Model:
   - State Diagram: Describes the state of the system while executing the Use Case.
   - Brief technical description explaining thoroughly the interaction diagrams specially the alternative and exceptional flows.
   - Class Diagrams: Comprehensive Diagrams explaining the global architecture of the module
   - Class Reference: Plain English Explanation of Classes.
   - Table of Controls: description of all fields that must be validated before adding it to the database. The field name is the attribute to be validated. The type of control shows the validation condition. And the associated message indicates the message that must be displayed to the user in case the field is not validated.

5. Given: This part contains a brief description of all modules and libraries that will be supplied to the developer and which he will need to use. If there is a specific documentation for those libraries and modules, they should be referenced here.

V. Developer Checklist

Windows based Applications Testing Checklist

Standardization Testing

Standardization means that the application being developed should have standard look and feel like any other window application. Test Cases are as follows:

☐ The application should have first "About Application" screen displayed

☐ Most of the screens/ dialog box (as on context) should have Minimize, Restore and Close clicks.

☐ Proper icon should be attributed to the application

☐ All screens/ dialog box should have a proper caption (Title, Description) as per the context used.

☐ The application should be seen in the Windows Task Bar as well as status bar.

☐ All application executable files should have file version, product name and company name information (.exe, .dll, .ocx, .sys. .cpl, .drv, .scr).

☐ The application's installer should start by way of Autorun.

☐ All application elements should look and behave normally when changing the monitor settings. For e.g. - 800x600 to 1280x1024 to 640x400 resolution and Large Size (120 DPI) font etc.

GUI Testing

☐ All the dialog boxes should have a consistent look through out the Application system. For e.g. - If the heading within a dialog box is blue then for each dialog box the heading should be of this color.

☐ Every field on the screen should have an associated Label.

☐ Every screen should have an equivalent OK and cancel button.

☐ The color combination used should be appealing.

☐ Every field in the dialog box should have a Short Cut Key support. For e.g. - User Name

☐ Tab order should be normally set horizontally for the fields. In some cases the Tab Order can be set vertically.

☐ Mandatory fields should have * (RED ASTERIK) marked to indicate that they are mandatory fields.

☐ Default key <Enter> should be set as OK for the dialog box.

☐ Default key <Esc> should be set as Cancel for the dialog box.

Validation Testing

Validation testing mainly depends on the fields set in the dialog box and the functions it has to perform. Test Cases are:

➢ For text box fields where value entered has to be numeric check following:

- ☐ It should accept numbers only and not alphabets.
- ☐ If field usage is such that for e.g., To accept
  Total number of days
  Telephone number
  Zip code etc.
  then it should not accept 0 and negative values.

➢ For text box fields where value entered has to be alpha-numeric check following:

- ☐ It should accept alphabets and numbers only.
- ☐ If field usage is such that for e.g., accepting
  First Name
  Middle Name
  Last Name
  City
  Country etc.
  then field value should start with an alphabet only.
- ☐ Depending on the condition this fields may accept special characters like -, _ , . etc

➢ If the field is a combo box then it has to be checked for following points:

- ☐ Check the combo box has drop down values in it, it is not empty.
- ☐ Drop down values should be alphabetically sorted. This might change as per requirement but as standard practices it should be alphabetically sorted. For e.g. to select data type from the list it will be as follows:
  Date
  Integer
  String
  Text, etc.
- ☐ Selection of any drop down value is displayed on closing and opening the same dialog box.
- ☐ By default some value like "Select Value" or "_____" string is displayed. This is because User comes to know that value is to be selected for this field. Avoid displaying the first default value in the list.

➢ If the field is a list box then it has to be checked for following points:

- ☐ Check the list box has values in it, it is not empty.
- ☐ List box values should be alphabetically sorted and displayed. This might change as per requirement but as standard practices it should be alphabetically sorted.
- ☐ Selection of any list box value should put a check before the value and should display the correct value(s) selected on closing and opening of the same dialog box.
- ☐ If the list box supports multiple selections then check whether multiple values can be selected.

➢ If the field is a list of radio button then it has to be checked for following points:

- ☐ Check whether as per requirements all the values are listed. For e.g.: to select date format, possible values displayed will be as follows:
  mm/dd/yyyy
  dd/mm/yyyy
  mm/dd/yy
  dd/mm/yy
  yyyy/mm/dd etc.
- ☐ Same selected value should be displayed on closing and opening of the same dialog box.

☐ Data Controls are to be tested as part of functionality testing.

Functionality Testing

☐ Check the functionality is covered as per Requirement specifications or Functional specifications developed for the software.

- Within a dialog box identify the dependent fields. Depending on the dependency check the enabling and disabling of the fields. For e.g.: to create Contact addresses in any application. To create contact addresses user should be able to add, delete and modify the information. Contact Addresses will contain information like, First Name, Last Name, Address1, Address2, City, State, Country, Zip, Phone, etc., any other information may also be added.
  This form will have the required fields and in addition to that will have Add, Delete and Update buttons. The functionality of the buttons is as follows:

  - ☐ Initially only Add button will be enabled. Delete, Update buttons will be disabled. This is because initially there is no data available and unless one adds one cannot delete or update. In short, unless there is a single valid record available it is not possible to update or delete.
  - ☐ Only on selecting a record from the list Delete and Update buttons are enabled and Add button is disabled. By default No records will be selected.
  - ☐ Delete and Update should always give confirmation message before actually performing the operation.
  - ☐ Delete operation should not show the deleted item in the list.

- Alerts:
  - ☐ Verify each alert identifies the problem first and then a solution
  - ☐ Verify alert text is not unnecessarily long (i.e., more than 3 lines)
  - ☐ Verify alert text is consistently worded and consistent in style
  - ☐ Verify alert text is correct and appropriate for the situation
  - ☐ Verify alert text contains complete sentences with correct capitalization and punctuation
  - ☐ Verify alert text avoids using abbreviations and acronyms
  - ☐ Verify alert text uses the product name where necessary, not "we"
  - ☐ Verify the buttons work correctly
  - ☐ Verify the buttons have unique access keys
  - ☐ Verify alert text is localized correctly
  - ☐ Verify the correct icon (Information, Warning, Critical) is displayed on the left hand side
  - ☐ Verify the title bar contains the name of the product (e.g., "Microsoft Bob")
  - ☐ Verify the buttons are centered below the message text

- Anti-Virus:
  - ☐ Test with and without anti-virus software installed

- Boundary Cases
  - ☐ Text length (e.g., of a list entry, in a field)
  - ☐ Extra-long filenames
  - ☐ Spaces in the text (e.g., of a list entry, field name)

- ☐ Duplicate items
- ☐ Large selection (e.g., the entire document or list)
- ☐ Giant files
- ☐ 4096 x 4096 pixel image
- ☐ Maximum number of objects (e.g., shapes, columns)
- ☐ Maximum and minimum values (e.g., for margins, values in edit boxes)

➢ Dialogs

- ☐ Verify default edit focus and default button focus is correct
- ☐ Verify tab order
- ☐ Verify mutually exclusive controls work correctly
- ☐ Verify all commands that launch dialogs (e.g., F12 to Save As)
- ☐ Verify every control has a short-cut letter, that all short-cuts work, and that every action can be executed via the keyboard
- ☐ Verify the dialog's title is correct
- ☐ Verify the menu command to show dialog is followed with "..."
- ☐ Verify the sizing and spacing of all controls matches the design standard
- ☐ Verify the correct system controls display on the title bar, and that they work correctly
- ☐ Verify help topics are correct
- ☐ Verify dialog tips (right-click on a control) are correct
- ☐ Verify status bar text is correct
- ☐ Verify the dialog displays and functions correctly with different color, font, and high contrast settings
- ☐ Verify the dialog displays and functions correctly in high DPI mode
- ☐ Verify all bitmaps being used with the text in the dialog are correctly localized
- ☐ Verify controls respond correctly to valid and invalid input
- ☐ Verify controls respond correctly to boundary case input (e.g., correct alerts are shown)
- ☐ Verify Escape cancels the dialog
- ☐ Verify the dialog is sticky (or not, as appropriate); i.e., it displays in same position as when last dismissed
- ☐ Verify settings in the dialog are saved (or not, as appropriate) the next time the dialog is invoked
- ☐ Verify the dialog is sized correctly in relation to its controls

➢ File Names

- ☐ With and without the complete path
- ☐ With and without the extension
- ☐ Long file names
- ☐ Short file names
- ☐ Deep directory levels
- ☐ International characters
- ☐ Invalid characters (e.g., '?')
- ☐ Invalid filenames (e.g., COM1, COM1.txt)

➢ Localization

- ☐ Verify controls in dialogs and elsewhere are aligned and sized correctly (e.g., text is not truncated)
- ☐ Verify any functionality affected by the localization process works correctly
- ☐ Verify data is ordered correctly
- ☐ Verify tab order is correct
- ☐ Verify no unlocalized strings remain
- ☐ Verify accelerators are localized
- ☐ Verify hot keys are localized
- ☐ Verify each accelerator is unique and consistent
- ☐ Verify each hot key is unique and consistent

➢ Menus and Command Bars
- ☐ Verify all commands work from menus and command bars
- ☐ Verify keyboard shortcuts are correct on all platforms
- ☐ Verify commands are visible and/or enabled only when appropriate
- ☐ Verify command captions are correct and consistent with similar terms used elsewhere
- ☐ Verify menu/command bar item context menus work correctly
- ☐ Verify status bar text is correct and not truncated

➢ Networking
- ☐ Verify correct handling of different levels of user access and permissions
- ☐ Verify correct handling of loss of network access
- ☐ Verify correct handling of user authentication requests
- ☐ Verify correct handling of file access via mapped drive (mapped root drive where supported)
- ☐ Verify correct handling of Print Preview when the network printer is disconnected
- ☐ Verify correct handling of long file name and long-file-name-to-short-file-name conversion correct

➢ Printing
- ☐ Verify changing orientation works properly
- ☐ Verify printing to a file works properly
- ☐ Verify "Number of Copies" works properly
- ☐ Verify color printing works properly
- ☐ Verify canceling printing works properly
- ☐ Verify scaling works properly
- ☐ Verify line or page numbering works properly (if supported)
- ☐ Print to both local and network printers
- ☐ Print to Adobe Acrobat to create PDF files

Web based Applications Testing Checklist

Usability, Interface and Navigation

☐ Is a navigational bar present on every screen?

☐ Is the navigation bar consistently located?

☐ Can a user navigate using text only?

☐ Can a user navigate without the use of a mouse?

☐ Does tabbing work consistently, in a uniform manner?

☐ Is there a link to home on every single page?

☐ Is page layout consistent from page to page?

☐ Is each page organized in an intuitive manner?

☐ Does text wrap properly around pictures/graphics?

☐ Are all referenced web sites or email addresses hyperlinked?

☐ Are hyperlink colors standard?

☐ Does the site look good on 640 x 480, 600x800 etc.?

☐ Are fonts too small to read (remember not everyone may have the same vision as you)?

☐ Are fonts too large?

☐ Is all text properly aligned?

☐ Are all graphics properly aligned?

☐ Is content legally correct (i.e. not filler content placed on site by developers during unit testing)?

☐ Is the page background (color) distraction free?

☐ Does the Back button work as intended? It should not open a new browser window, redirect you to another site, prevent caching such that the Back navigation requires a fresh trip to the server; all hypertext navigation should be sub-second and this goes double for backtracking

☐ Does content remain if you need to go back to a previous page, or if you move forward to another new page?

☐ Are all of the links on a page the same as they were before? Are there new or missing links?

☐ Are there any broken links?

☐ Does a link bring you to the page it said it would?

☐ Does the page you are linking to exist?

☐ Is contact information for the site owner readily visible and available (name, telephone number, email address, mailing address, fax number)?

☐ If a user wishes to bookmark a page, is the page name easily understandable?

☐ Does your site's Web address appear in the History list if the user allows for historical page recording?

☐ Does the status bar on each Web page accurately reflect the progress of page loading, information, etc.?

Data Verification

☐ Can text be entered in numeric fields?

☐ Can spaces and blank values be entered in fields?

☐ Are long strings accepted?

☐ Do fields allow for the maximum amount of text to be entered?

☐ Are the initial values of checkboxes and radio buttons correct?

☐ Are you restricted to only selecting one radio button in a group at one time?

☐ Do check boxes trigger the desired event?

☐ Are users prevented from entering HTML code in form fields?

☐ Is intelligent error handling built into your data verification? IE. If Date of Birth is a required field MM/DD/YYYY, it is unlikely that the person entering the data was born in 1857.

Generic Installation Testing Checklist

☐ Support of the different platforms and configurations needed?

☐ Does the Installation in "clean state" work?

☐ Is the installer able to calculate needed disk space?

☐ Does the installer capture the baseline free space before launching the installer?

☐ Is the amount of space the installer claims it needs for the various type of installation actually taken up or is there any discrepancy?

☐ Does the installation recover in case an error is met during the installation?

☐ Is the installer able to Repair any corrupt installation?

☐ Is the application installed properly for each type of installation (for typical, custom and complete)?

☐ Does the Installation over network work?

☐ If any file association is made during installation, upon uninstall, does the association is removed and the base file association is returned to the files?

☐ Does the Uninstall leave any registry entry, data files in the system?

☐ If a version of the application to be installed already exists on the machine, does the installer identify that?

- ☐ Does the installer identify if some needed components (such as, MSDE etc.) are already installed on the system?
- ☐ Do running two instances of the installer prompt a message to the user that an installation setup is already running?
- ☐ If the user logged in, without having write permission for the machine, how installation reacts to this?
- ☐ What happens if the installer tries to install to a directory where there is no write access?
- ☐ Check to ensure that when installing the product, it should provide a browse button which enables the user to install at any folder, and it should provide by default folder (For ex: C:\program files)
- ☐ Is the registering and un-registering the components (dlls) on installation and uninstall is occurring properly?
- ☐ Are all the files installed in the respective folders and path?
- ☐ Whether all the files/registry values/services are installed properly.
- ☐ Check whether the shortcuts are installed properly and also the PATH (any other ENV variables) is updated properly. (It can be CURRENT USERS profile or All Users profile based on your requirements).
- ☐ Does the installation support, 'Uninstall', 'Modify', 'Reinstall' options?? If yes, does it work?
- ☐ If the installer is supporting upgrade feature, does it preserve all the necessary settings (mostly user preferences)?
- ☐ Check for the user privileges before starting installation. (In most of the cases, installer requires ADMIN privileges).
- ☐ Check the uninstaller entry in add-remove programs. (Check for display string, Display icon and Support information etc.).
- ☐ Does running the installer, and then running the uninstaller, return the machine to the base state?
- ☐ Reinstallation should, apart from identifying previous versions, also should give an option to Remove and Repair.
- ☐ Check to ensure that license key is properly stored in Windows Registry library.
- ☐ Check to ensure that if an evaluation version is installed, then a proper message should be displayed when the date of period is expired for evaluation version with proper error message.
- ☐ Check to ensure that, if Windows Services are installed then it should install in the Services folder of windows directory.
- ☐ Check to ensure that if any product is installed and it is dependent on some other product, then it should give proper message as "The Product is not installed and it should exit". Check for dependencies.

☐ If the product to be installed uses any third party dll and if it is already installed by some other product confirm that the current installation doesn't un-register/tamper it and uses the existing one.

☐ If the dll is already there in the system how does the installation work?

☐ And also while uninstalling, check should be made as to whether that the shared dll is left without affecting other product.

Appendix G
Inception time calculations

Table 8: Inception Phase Timeline Progress over 1 Year

	Weeks		
	SecurPmt	Project A 15% less	Project B 25 % less
primary research	**1**	**1**	**1**
features analysis	**2**	**2**	**2**
BDP	**4**	**3.4**	**2.55**
global Soft Arch	**3**	**2.55**	**2**
test plan draft	**2**	**1.7**	**1.3**
reading doc	**4**	**3.4**	**2.55**
project plan	**1**	**1**	**1**

Figure 15: Distribution of Tasks by Weeks