An-Najah National University
Faculty of Graduate Studies

Software Development Process Improvement for Small Palestinian Software Development Companies

By
Asem Bassam Mahmoud Isawi

Supervisor
Dr.Baker Abdulhaq

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This thesis was defended successfully on 26/5/2011 and approved by:

Defense Committee Members	Signature
1. Dr. Baker Abdulhaq / Supervisor	.....
2. Dr. Emad Saadeh / External Examiner	.....
3 Dr. Ahmad Shraideh / Internal Examiner	.....

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الإقرار

أنا الموقع اسمي أدناه مقدم الرسالة التي تحمل العنوان:

Software Development Process Improvement for Small Palestinian Software Development Companies

تحسين عملية تطوير البرمجيات في الشركات الفلسطينية الصغيرة

اقر بأن ما اشتملت عليه هذه الرسالة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الإشارة إليه حيثما ورد، وان هذه الرسالة ككل، أو أي جزء منها لم يقدم من قبل لنيل أية درجة علمية أو بحث علمي أو بحثي لدى أية مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this thesis, unless otherwise referenced, is there searcher's own work, and has not been submitted elsewhere for any other degree of qualification.

Student's name: **اسم الطالب:**

Signature: **التوقيع:**

Date: **التاريخ:**

Abbreviations

CMMI: Capability Maturity Model Integration.

ISO/IEC: International Organization for Standardization/International Electrotechnical Commission.

ISO: International Organization for Standardization.

PITA: Palestinian Information Technology Association.

SDPI: Software Development Process Improvement.

SEI: Software Engineering Institute.

Small Software Organization: A company that employs 2-10 employees and produces software products.

SPICE: Software Process Improvement and Capability Determination

SW-CMM: Software Capability Maturity Model.

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Software Development Process Improvement for Small Palestinian Software Development Companies

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Abstract

The purpose of this study was to develop a model for small Palestinian software development firms that will help them in making a self-evaluation for their software development process and find areas to improve.

A large number of universities, research centers, and associations around the world have tried to find their own answers to this issue by proposing software process improvement models that are dedicated for the use inside small and very small software enterprises. However, the proposed solutions were still too complicated and cannot be applied easily by these firms and none of them represented a solution that fits all small firms. Moreover, all of these frameworks were built such that they fit the country from which the information was gathered.

Accordingly and taking into consideration the culture context when applying western SPI models for the purpose of improving software processes, the researcher has introduced a simplified framework which he named PAL-SPI that offers an easy to understand and easy to apply software process improvement framework.

A quantitative research methodology was used in this study. The survey was designed based on Capability Maturity Model Integration (CMMI V1.3) and a number of models that were designed for the same purpose in other countries such as Software Process Improvement Model for Small Organizations (SPISO) model. The data was gathered with the aid of an online survey. Forty surveys were sent to small software development firms in Palestine and thirty responses were received over a period of five weeks. The response rate was seventy five percent.

Chapter 1
Introduction

1.1. Overview

In today's business world, with a lot of systems that is characterized by complexity and variability; Software development firms should continuously look and apply efficient, effective, cost effective, and time saving processes in order to help them in developing and delivering high quality software products and attaining and sustaining competitiveness. Moreover, it is critical for these companies to continuously seek for practical and useful guidelines, models, and techniques that help them in improving their software processes as part of their continuous improvement strategy. In this context, the Palestinian software industry recognizes the value of small software development firms in contributing valuable products and services to the economy.

Today, there are several software process improvement models such as the capability Maturity Model Integrations (CMMI) and the Software Process Improvement and Capability Determination model (SPICE) which can be used to improve software development process and assess organization’s maturity; however some articles written by others [e.g. Laporte 2008; Maschi 2008 and Sivashankar 2010] stated that all of these models are not suitable to apply in small software firms because small software firms often face budget, time, and resource constraints when they approach process improvement. Compounded to these challenges, small software development firms also lack the experience and skills in starting

the “quality improvement journey” [Mondragon, 2006; Revankar, Mithare, & Nallagonda, 2006]. In Addition, although senior or middle managers in these small organizations realize the benefits of process improvement and are willing to devote effort, they lack guidelines of effective approach for the process improvement project [Leung 2008].

1.2. Related Work

A large number of universities, research centers, and associations from all over the world have tried to find their own answers to this issue that is being faced by small and very small software firms. They proposed software process improvement models that are dedicated for the use inside small and very small software enterprises. However, the proposed solutions are still too complicated and cannot be applied by small and very small software firms. Moreover, none of these universities, research centers and associations has been able to propose a one-size-fits-all solution for any context taking into account all previous experience and knowledge [Mishra 2008].

These conditions have led the researcher to put his effort to develop a simplified framework that is easy to understand, easy to apply and adopt by small Palestinian software development firms. The intended framework aims to help them small software development firms in having an effective software development process that leads to high quality software products by enabling these firms to assess their current software processes and find areas to improve.

1.3. Research Objectives

Based on the above introduction about software process improvement for small software development firms, this research aims to:

1) Asses the current situation of software process improvement inside small Palestinian software development firms.

2) Enable small Palestinian software development firms to assess their current software process/s and find areas to improve.

3) Propose a process improvement model that is dedicated for the use inside small Palestinian software development firms.

1.4. Research Design and Methodology

In order to achieve the objectives mentioned above, an empirical research needs to be conducted on small software development firms in Palestine. The collected data shall be analyzed in order to come up with a frame work that achieves the research objectives and answers its questions.

In this research, the researcher has tried to customize a framework which fits research environment considerations and constrains. Some of the ideas in the proposed framework have been taken from other frameworks and other related researches that are mentioned later in chapter 3.

1.5. Research Questions

The research wanted to investigate small Palestinian software firms' view on Software Process Improvement (SPI) and propose a model that is

aligned with their view. Based on this and considering the last version of CMMI model (V1.3), the research aims to seek answers for the following questions:

- Are there Process Areas that can be excluded when pursing process improvement in small software firms?
- What Process Areas of SPI are most applied in small Palestinian software development firms?
- What Process Areas of SPI are considered most important by small Palestinian firms?

1.6. Research Importance

Small software firms play a fundamental role in most countries economies, and they represent up to 85% of all software firms in the US, Canada, China, India, Finland, Ireland, and many other countries [Mejhem 2009].

According to Mishra, Presently the majority of software development, including outsourcing, is carried out by small size software development firms all over the world [Mishra 2008]. These firms are not capable to bear the cost of implementing available software process improvement models like CMMI, SPICE and ISO [Mishra 2008]. Therefore, there is a need to address this problem and raise the need for the development of standardized software process improvement model for small sized software development organizations. All initiatives and

researches [e.g. Laporte 2008; Maschi 2008] that were conducted in this field have come to the same conclusion which is; existing software process models are not easily applicable in small and medium organizations and no one has been able to propose a one-size-fits-all solution for any context.

Designing a framework based on small Palestinian software firm's view, will make them more willing to incorporate process improvement within their software process. Also, designing such model would facilitate evolving small software development firms in Palestinian market and would help existing firms in assessing their software process and find areas to improve and hence enable them in producing high quality software products.

1.7. Thesis Outline

The thesis will be comprised of seven chapters as shown in Table 1.1. Following the introductory chapter, which introduces the reader to the topic, Chapter 2 will describe software development process and software development process improvement, the importance of SPI and identified SPI problems inside small software firms, Chapter 3 will present reviews on related literature on software process improvement for small firms and related topics, compare these models and address the cultural impact on SPI. Chapter 4 will present the choice of the research method, survey population characteristics and data collection approach. Chapters 5 will discuss and present the survey results and analysis them. Chapter 6 will present the framework and how it was designed and its implementation

guidelines. Finally, Chapter 7 will conclude the study results through an articulation of the research findings, and conclusions.

Table (1.1): Outline of the thesis

Chapter	Chapter Name	Overview
Chapter 1	Introduction	This chapter introduces the reader to the research topic.
Chapter 2	An Overview about Software Process Improvement	This chapter provides the reader with an overview about the SPI.
Chapter 3	Literature Review	This chapter discusses a number of software process improvement models that were designed for small software firms. These models will be compared and the cultural impact on SPI will be discussed as well.
Chapter 4	Research	This chapter provides the reader with information about the research including its methodology, population and data collection approach.
Chapter 5	Survey Results and Analysis	This chapter presents the results of the empirical research and analyses its results in order to propose the model.
Chapter 6	Model proposal	This chapter describes proposed model and provides the reader with detailed information about how it was designed.
Chapter 7	Conclusion and Recommendations	This chapter discusses the conclusion made through this research and the contribution made to the domain. It also provides recommendations for future work.

Chapter 2
Overview about Software Process Improvement (SPI)

2.1. Introduction

The Purpose of this chapter is to introduce the reader to software process and software process improvement and show the conceptual difference between them. It will also present some identified software process improvement problems inside small software development firms.

2.2. Software Process and Software Process Improvement

The following sections will define what software process is, what is software process improvement and highlights the conceptual difference between these two different terms.

2.2.1. Software Process

A Software Process can be defined as the structure imposed on the development of a software product. It is also known as a software life cycle and software development process.

According to Yack, “Software Process describes the phases of the software cycle and the order in which those phases are executed. Each phase produces deliverables required by the next phase in the life cycle. Requirements are translated into design. Code is produced during implementation that is driven by the design. Testing verifies the deliverable of the implementation phase against requirements” [Yack 2005].

Yack summarized the traditional software development process models with the following models:

- Waterfall Model
- V-Shaped Model
- Incremental Model
- Spiral Model

2.2.2. Software Process Improvement

According to Sommerville, the software process improvement is used to understand the current processes and doing changes on the process in order to improve the product quality, reduce cost, or accelerate schedules [Mejhem 2009]. According to Karl Wiegers; software process improvement is defined as constantly applying the practices that give you good results, and change the practices that cause problems [Vasljevic 2003].

Today, there are several models for such process improvement; each describes approaches to a variety of tasks or activities that take place during the process. Of such models, the Software Engineering Institute's Capability Maturity Integration Model (CMMI) and other models that are described later in the next chapter (Chapter 3 - Software Process Improvement Models).

According to Vasljevic, “the main goal and motivation for SPI practitioner to achieve specific business results within specific time and with pleasing quality, and this should be achieved through better software development and management processes and activities” [Vasljevic 2003].

2.3. Small Software Development Firms

The term “Small” refers to the number of employees inside the organization and this number is different between countries. According to Thapliyal, Indian Small and Medium Enterprises (SMEs) employ fewer than 20 employees [Thapliyal 2010]. Vasljevic defined small company with less than 40 employees. Mejhem and others concluded that the size of small software firms is between 10 and 50 employees [Mejhem 2009]. Based on this information, the researcher has defined small Palestinian software firm with any software development Palestinian firm that employees less than 50 employees.

2.4. SPI Problems in Small Software Firms

Small sized companies often face budget, time, and resource constraints when they approach process improvement [Mondragon 2006]. These firms also lack the required experience and skills needed to start the “quality improvement journey” [Vasljevic 2003]. Moreover, although senior management or middle managers in these organizations realize the benefits of process improvement and are willing to devote effort, they lack guidelines of effective approach for the improvement project.

The following points present the identified problems in software process improvement for small firms based on the information retrieved from literature:

- **Limited Resources:** The proper implementation of software engineering techniques is a difficult task for small organization as they often operate on limited resources and with strict time constraints.
- **Cultural Issues:** like resistance to change from the employees or management who consider the extra work required for quality assurance as a useless and complicated burden put on the development team.
- **Budget and Time Constraints:** Budget and time constraints are an important constraints to improve the software quality especially when discussing SPI for small firms.

2.5. Summary of the chapter

In this chapter the software process improvement and the software process were defined and the difference between them was discussed as well.

The small Palestinian software development firm was defined with any software development firm that employee less than 50 employees.

Finally, Budget constraints, limited resources and cultural issues were the main issues faced by small software firms.

Chapter 3
Literature Review

3.1. Introduction

This chapter is divided into two main sections; the first is intended to show the centers and initiatives around the world that focused on software process improvement in small and very small software firms, while the other section is intended to list some of the models that were developed for SPI in small and very small software firms. At the end of the chapter, the models for small software firms will be compared and the cultural effect on SPI will be addressed.

3.1.1. Centers and Initiatives focusing on small and very small software firms

A large number of universities, research centers, and associations from all over the world have tried to find their own answers to the issue being faced by most small and very small software firms, and proposed software process models dedicated to them. However, at this point, no one has been able to propose a unified solution that fits small software firms taking all previous experience and knowledge into account because these solutions are still too complicated to be applied by small and very small software firms [Mishra 2008]. The following sections present some of these initiatives:

3.1.2. Centre for Software Process Technologies | United King Dom

The Centre for Software Process Technologies (CSPT) is a research and knowledge transfer organization hosted by the Faculty of Engineering at the University of Ulster. The CSPT published a paper showed that the priorities and concerns of small software organizations are quite different from those of larger ones [Laporte 2008].

The CSPT published the results of its first six assessments in small and medium software enterprises (SMEs) using its express process appraisal (EPA) method. The EPA model assesses six of the seven process areas at maturity level 2 [Laporte 2008]:

- Requirements Management.
- Configuration Management.
- Project Planning.
- Project Monitoring and Control.
- Measurement and Analysis.
- Process and Product Quality Assurance.

3.1.3. Toward Software Excellence | British

Toward Software Excellence (TSE) provided a self-assessment “health check” facility and corresponding guidance on best practices and is based on the ISO/IEC TR 15504 International Standard. It proposes an

interesting mix of functionalities and characteristics that can explain small organizations' success: it uses business language and addresses the business perspective of the process issue, aiming at solving business problems first and highlighting the importance of customer relationships. TSE is much more than an assessment tool as it helps to explain issues to people using a language they can understand [Laporte 2008, Daily 2004].

3.1.4. European Software Institute – IT Mark | ESI

The European Software Institute (ESI) is a technological center with an aim to contribute to developing the information society and to increase industry competitiveness by means of knowledge, innovation, continuous improvement, and the promotion and dissemination of IT. The ESI established a network of partners, called ESI@net, with companies in which activities are related to software process improvement and IT in general. The ESI Centre Alliance has launched the IT Mark Certification worldwide, which aimed at certifying the quality and maturity of the processes in SMEs that develop and maintain IT systems. IT Mark assesses and certifies the quality of SMEs in three main areas [Laporte 2008]:

- Business management (overall management: strategic, commercial, financial, marketing, etc.);
- Information security management;
- Software and systems processes maturity. For software and systems processes, a lightweight version of CMMI (2002) was used.

3.1.5. SataSDPIN | Finland

SataSDPIN is a regional network for small and medium software firms who are interested in making improvements. Its main goal was to set up an SPI program in each of the participating companies with a view to establishing a network of companies promoting good software practices in the region.

SataSDPIN project used the ISO/IEC 15504 standard as the software process assessment tool and improvement framework [Laporte 2008].

3.1.6. NORMAPME |Europe

NORMAPME is an international nonprofit association that provides standardized process to small and medium enterprises created in 1996 with the support of the European Commission and the only European organization focusing on small enterprise interests in the European standardization system because it found that SMEs represent over 90% of European companies, and they employ nearly 81 million people, which is 66% of Europe's total employment. NORMAPME sees that Standards are essential for SMEs today, as they are for any company operating in an internal market and results in enlarging the potential market for products, facilitating product acceptance, lowering transaction costs, achieving economies of scale, and so on. However, SMEs lack knowledge with respect to standards and standardization, and they need some support to help them implement existing standards, as well as have a voice in the standardization process [Laporte 2008].

3.1.7. Software Quality Institute | Australia

The Software Quality Institute at Griffith University in Australia developed the rapid assessment for process improvement for software development (RAPID) method in conformity with ISO/IEC 15504. RAPID was developed for SMEs with limited investment of time and resources.

The model includes eight ISO/IEC 15504 processes:

- Requirements Gathering.
- Software Development.
- Project Management.
- Configuration Management.
- Quality Assurance.
- Problem Resolution.
- Risk Management.
- Process Establishment.

The scope of the model is limited to Levels 1, 2, and 3, although capability ratings at Levels 4 and 5 are possible [Laporte 2008, Cater-Steel 2006].

3.1.8. The Mexican standard | Mexico

A Mexican standard was developed at the request of the ministry of economy in order to provide the software industry there with a model based

on international practices that is easy to understand, easy to apply, and economical for adoption.

The Mexican standard approach provided the basis on which to achieve successful evaluations with other standards such as ISO 9000:2000 or CMMI.

The Mexican standard (NMX-059-NYCE, 2005) is divided into four parts: [Laporte 2008]

- Part 1: Definition of Concepts and Products.
- Part 2: Process Requirements (MoProSoft).
- Part 3: Guidelines for Process Implementation.
- Part 4: Guidelines for Process Assessment (EvalProSoft).

3.1.9. The Association of Thai Software Industry (ATSI) | Thailand

The Association of Thai Software Industry (ATSI) developed the Thai Quality Software (TQS) standard to provide Thai Very Small Enterprises with a way to improve their process quality using a standard as a reference model. TQS is a staged implementation of ISO/IEC 12207, where different processes are implemented at each of five capability levels, where each level has different requirements (L1=records; L2=procedures, plans; L3, L4, L5=more processes) [Laporte 2008].

3.1.10. Centre d'Excellence en Technologies de l'Information et de la Communication (CETIC) | Belgium

The Centre d'Excellence en Technologies de l'Information et de la Communication (CETIC), located in Wallonia (Belgium), focuses on applied research and technology transfer in the field of software engineering and electronic systems. CETIC is a connecting agent between academic research and industrial companies. At the University of Namur, a software process improvement approach dedicated to small development structures has been developed. The method, called Micro-Evaluation, has been used and improved in collaboration with CETIC and the Department of Software and IT Engineering at the Ecole de Technologie Supérieure (ETS, Québec, Canada). [Laporte 2008, NISS 2010]

3.2. Models for Small Firms

This section will look in brief at previously established models that are tailored for small software development companies in different countries around the world.

3.2.1. QuickLocus

QuickLocus is a special-purpose evaluation method of software process developed to be applied in small-sized organizations. QuickLocus is considered as low-cost methodology and can offer small software organizations greater competitiveness and allow competing in the global software marketplace.

Like other models, QuickLocus can be applied in an improvement program for software products, enabling the first step for every program which is the evaluation of software development and maintenance processes for small-sized organizations [Kohan 2008].

The QuickLocus is considered as phased approach with three main phases; Readiness, Evaluation and Post evaluation.

3.2.2. ADEPT: A Unified Assessment Method for Small Software Companies

Through ADEPT model, 12 key Process Areas have been proposed based on CMMI [Fergal 2007]:

- Requirement Management
- Configuration Management
- Project Planning
- Project Monitoring and Control
- Measurement and Analysis
- Process and Product Quality Assurance
- Risk Management
- Technical Solution
- Verification

- Validation
- Requirement Development
- Product Integration.

3.2.3. MPS.BR Model

Through this model 23 process areas have been proposed based on ISO 12207 and CMMI [Sivashankar 2010]:

- Organizational Innovation and Deployment
- Casual Analysis and Resolution
- Organizational Process performance
- Quantitative Project Management
- Risk Management
- Decision Analysis and Resolution
- Requirement Development
- Technical solution
- Validation
- Verification
- Software Integration

- Product Release
- Training
- Process Establishment
- Process Assessment and Improvement
- A Tailoring process for project management
- Configuration management
- Quality Assurance
- Acquisition
- Measurement
- Project management
- Requirement Management

3.2.4. CMM Fast-Track

The model was specifically designed for helping software SMEs in Hong Kong to fast track their quality and process improvement efforts because CMMI is not suitable to apply in small firms due to the following constraints for implementing CMMI [Leung 2008]:

- Lack of resources
- Language and process culture barrier

- Difficult to disseminate CMMI concepts and importance
- Very steep learning curve for people new to process culture

CMM Fast-Track includes the following process areas:

- Configuration Management
- Decision Analysis and Resolution
- Integrated Teaming
- Organizational Environment For Integration
- Measurement and Analysis
- Organizational Process Focus
- Organizational Process Definition
- Technical Solution
- Product Integration
- Project Planning
- Project Monitoring and Control
- Integrated Project Management
- Risk Management
- Process and Product Quality Assurance

- Requirement Development
- Requirement Management
- Supplier Agreement Management
- Integrated Supplier Management
- Organizational Training
- Validation
- Verification

3.2.5. SPISO Model

SPISO stands for Software Process Improvement for Small Organizations. SPISO model was designed based on SW-CMM, CMMI V1.1, and ISO 9001:2000 by Daniel Vasiljevic and Stefan Skoog. This model was designed using an empirical study conducted on small software development firms in Sweden with the aim to find out the important SPI activities for small software development firms from a purchaser's and a small software firm's point of view.

The SPISO Model describes an evolutionary path for small software development firms towards becoming a mature organization [Vasiljevic 2003]. The SPISO model included the following process areas:

- Requirements Development

- Customer Communication
- Technical Solution
- Supplier Agreement Management
- Product Integration
- Requirements Management
- Software Project Tracing and Oversight
- Integrated Project Management
- Project Planning
- Validation
- Decision Analysis and Resolution
- Verification
- Configuration Management
- Process and Product Quality Assurance
- Organizational Training
- Causal Analysis and Resolution – Defect Prevention
- Organizational Process Definition
- Risk Management

3.2.6. MoProSoft

MoProSoft is a software process model specific for small enterprises in Mexico who are especially interested in adopting it as a first step to achieve a CMMI level. MoProSoft has made it clear that software process improvement in small enterprises is possible through simplified versions of good practices created by and for big companies [Oktaba 2008].

MoProSoft has been developed after rearrangement, summary, and compilation of CMMI, ISO 9000:2000, ISO/IEC 12207, ISO/IEC and ISO 10006.

3.2.7. Agile SDPI

Agile SDPI is a framework that aims to motivate small and medium size enterprises towards improving and certifying their software development processes. Agile SDPI framework based on models lightweight, international standards, agile improvement, and agile practices.

Agile SDPI was designed for SME industry and is flexible and permits the inclusion of other models [Hurtado 2008].

3.2.8. COMPETISOFT

The COMPETISOFT project’s main aim is to provide the software industry in Latin America with a reference framework for software process improvement and certification, which will enable it to be more competitive in the global market. The COMPETISOFT project aims to increase the

competitiveness of SMEs in Latin America by means of a methodological framework suited to their special characteristics. This framework establishes the necessary elements to guide SPI initiatives in SMEs in an economical way in a short period of time with few resources.

The framework was composed of three models [Oktaba 2008]:

- Process reference model: This describes good practices for the development of software.
- Evaluation model: this allows generating a quantitative score which characterizes the process capability.
- A model for guiding process improvement; this model provides guidelines for the carrying out improvements inside of processes of the organizations.

One of the strategies of the COMPETISOFT project has been the analysis of existing offers which have demonstrated success in SMEs. Thus, COMPETISOFT is highly influenced by proposals such as MoProSoft, EvalProSoft, and Agile SDPI. As future work, the COMPETISOFT framework will be refined and improved on the basis of feedback and lessons learned with the current application of the process reference, evaluation, and improvement models in the different companies involved in the project [Villarroel 2010, Oktaba 2008].

3.2.9. Software Process Matrix (SPM) Model

The SPM model provides the small software firms with a ranked list of actions which can be input to their software process improvement strategy. SPM is based on quality function deployment (QFD). This model helps the firm in finding the relative importance of software processes. The SPM model uses self-assessment within the organizations and can be used to establish an improvement strategy based on QFD.

The SPM Relates to the company's business goals, focuses on the most important software process, gives maximum value for money, proposes improvements which have maximum, effect in as short a time as possible, provides fast return on investment (ROI), is process oriented, relates to other software models, and is flexible and easy to use [Mishra 2008, Richardson 2001].

3.2.10. A software development Model for small Brazilian companies

This model is based on the needs of a small Brazilian software development firms and the software engineering concepts recognized by the RUP, MSF, and agile modeling. The model was created with four phases that define the life cycle of the software development projects. At each cycle of the project, a new set of document and software artifacts is delivered to the customer. This model can help small Brazilian software firms to improve their competitiveness in global software markets.. Based on the report issued by the SEI for CMMI level 2 obtained in April 2006,

the success of the implementation of this model led the company that was the object of the study to create a software factory [Maschi 2008].

3.2.11. MESOPYME

MESOPYME is a continuous software process improvement method which is intended for the use inside Small and Medium software Enterprises. MESOPYME has been defined, taking into account a generic SDPI model defined by ISDPI (ESSI, 1994) with four stages [IEEE 2010, Mishra 2008]:

- **Stage 1: Commitment to improvement**. Its objective is to obtain the support of senior management to carry out the improvement project.
- **Stage 2: Software process assessment**. Its objective is to obtain strengths and weaknesses of the process assessed with respect to a software process model—CMM. From this assessment, processes to be improved are identified.
- **Stage 3: Improvement solution**. Its objective is to provide the needed infrastructure to carry out improvement feedback from stakeholders and to create the plan to follow in order to define and implement improvement in these selected processes.
- Stage 4: **Institutionalize**. Finally, improvement must be institutionalized.

3.2.12. Capability Maturity Model for Software SW-CMM

The Capability Maturity Model for Software (CMM or SW-CMM) is a model for judging the maturity of the software processes of an organization and for identifying the key practices that are required to increase the maturity of these processes. The SW-CMM has been developed by the software community with stewardship by the Software Engineering Institute at Carnegie Mellon University [SEI 2003].

The Software CMM which has become a de facto standard for assessing and improving software processes describes the principles and practices underlying software process maturity and is intended to help software organizations improve the maturity of their software processes in terms of an evolutionary path from ad hoc, chaotic processes to mature; disciplined software processes [Vasiljevic 2003].

3.2.13. The Capability Maturity Model Integration (CMMI)

CMMI is the successor of the capability maturity model (CMM) or software CMM. The CMM was developed from 1987 until 1997. In 2002, CMMI Version 1.1 was released, Version 1.2 followed in August 2006, and Version 1.3 was recently released in October 2010.

Depending on the CMMI constellation (acquisition, services, development) used, the Process Areas it contains will vary. Key Process Areas are the areas that will be covered by the organization's processes. The table below lists the process areas that were presented in all CMMI

constellations. This collection of eight process areas is called the CMMI Model Framework, or CMF.

Table (3-1): Capability Maturity Model Integration (CMMI) Model Framework (CMF)

Abbreviation	Name	Area	Maturity Level
REQM	Requirements Management	Engineering	2
PMC	Project Monitoring and Control	Project Management	2
PP	Project Planning	Project Management	2
CM	Configuration Management	Support	2
MA	Measurement and Analysis	Support	2
PPQA	Process and Product Quality Assurance	Support	2
OPD	Organizational Process Definition	Process Management	3
CAR	Causal Analysis	Support	5

There are five maturity levels in CMMI. However, maturity level ratings are awarded for levels 2 through 5. The process areas below and their maturity levels are listed for the CMMI for development model [SEI 2010]:

Maturity Level 2 - Managed

- CM - Configuration Management
- MA - Measurement and Analysis
- PMC - Project Monitoring and Control
- PP - Project Planning

- PPQA - Process and Product Quality Assurance
- REQM - Requirements Management
- SAM - Supplier Agreement Management

Maturity Level 3 - Defined

- DAR - Decision Analysis and Resolution
- IPM - Integrated Project Management
- OPD - Organizational Process Definition
- OPF - Organizational Process Focus
- OT - Organizational Training
- PI - Product Integration
- RD - Requirements Development
- RSKM - Risk Management
- TS - Technical Solution
- VAL - Validation
- VER - Verification

Maturity Level 4 - Quantitatively Managed

- OPP - Organizational Process Performance

- QPM - Quantitative Project Management

Maturity Level 5 - Optimizing

- CAR - Causal Analysis and Resolution
- OPM - Organizational Performance Management

3.3. Models Comparison

Although it is difficult to compare the mentioned SPI models because of their divergent characteristics, the researcher tried to find out some significant characteristics in order to have a comparative view about these models and was able to come up with the following points:

1) These SPI models are specifically developed for small and medium enterprises because these firms do not have the resources and cannot bear the cost to implement the standards that are designed to be used by large firms such as CMMI and ISO.
2) The discussed models were developed based on some existing methods such as CMM, CMMI, ISO, and QFD. For example, MESOPYME developed based on CMM, PRISMS developed based on CMM and GQM, and SPM developed based QFD.
3) The methods that were designed for the use inside large firms such as CMM, CMMI, ISO, and QFD were customized and simplified by incorporating some additional questionnaires or processes in order to create customized and simplified versions of the models that can be used by small and medium software development firms.

4) The developed methods can help small and medium enterprises to find out the areas that needs improvement and provide these firms with roadmaps for how to improve these areas.
5) All of the developed models require assessment for the current situation/process inside small and medium enterprises in order to identify the key process areas that need to be improved.
6) Each of these models aims to come up with a prioritized list of actions, goals and process guides that aims to achieve improvements in software development process.
7) Each of the discussed models, has been developed and intended for the use inside the country that was developed in. the data has also been collected from small and medium sized enterprises inside these countries. For example, CMM Fast Track has been developed for the use of software development companies in Hon Kong, MoProSoft has been developed to be used by Mexican software development companies and COMPETISOFT was developed for Latin America software development companies.
8) Table 4-2 compares some of the discussed models in this chapter based on origin, standards used and key Process Areas included.

Table (3-2): Comparing SPI models for SME's

Criteria	Model					
	SPISO	CMM FT	ADEPT	EPA	RAPID	MPS.BR Model
Origin	Sweden	Hong Kong	Ireland	UK	Australia	Brazil
Based On	CMMI,ISO	CMMI	CMMI	CMMI	ISO/IEC 15504	ISO 12207 and CMMI
Process Areas	Requirements Development	Configuration management	Requirement Management	Requirements management.	Requirements gathering.	Organizational Innovation and Deployment
	Customer Communication	Decision Analysis and Resolution	Configuration Management	Configuration management.	Software development.	Casual Analysis and Resolution
	Technical Solution	Integrated teaming	Project planning	Project planning.	Project management.	Organizational Process performance
	Supplier Agreement Management	Organizational Environment for integration	Project monitoring and control	Project monitoring and control.	Configuration management.	Quantitative Project Management
	Product Integration	Measurement and analysis	measurement and analysis	Measurement and analysis.	Quality assurance.	Risk Management
	Requirements Management	Organizational Process Focus	process and product quality assurance	Process and product quality assurance.	Problem resolution.	Decision Analysis and Resolution
	Software Project Tracing And Oversight	Organizational Process Definition	Risk Management		Risk management.	Requirement Development
	Integrated Project Management	Technical solution	Technical solution		Process establishment.	Technical solution
	Project Planning	Product Integration	Verification			Validation
	Validation	Project Planning	Validation			Verification
	Decision Analysis And Resolution	Project Monitoring and Control	Requirement development			Software Integration
	Verification	Integrated Project management	Product integration.			Product Release
	Configuration Management	Risk Management				Training
	Process And Product Quality Assurance	Process and Product Quality Assurance				Process Establishment
	Organizational Training	Requirement Development				Process Assessment and Improvement
	Causal Analysis And Resolution – Defect Prevention	Requirement Management				A Tailoring process for project management
	Organizational Process Definition	Supplier Agreement Management				Configuration management
	Risk Management	Integrated supplier management				Quality Assurance

		Organizational Innovation And Deployment	Organizational Training				Acquisition
		Organizational Process Performance	Validation				Measurement
		Organizational Process Focus	Verification				Project management
		Quantitative Project Management					
		Measurement And Analysis					

Table 3-3 includes the frequency of each CMMI Process Area in the compared models. Both Configuration Management and Project Monitoring and Control are contained in the six models while Requirement Development, Risk Management, Project Planning, Project Planning and Process and Product Quality Assurance are included within 5 out of the six models.

Table (3-3): Frequency of CMMI Process Areas in the compared models sorted by the most frequent

Process Area	Frequency
Configuration Management	6
Project Monitoring and Control	6
Requirement Development	5
Risk Management	5
Project Planning	5
Process And Product Quality Assurance	5
Requirements Management	4
Validation	4
Verification	4
Technical Solution	4
Measurement And Analysis	4
Product Integration	3
Decision Analysis And Resolution	3
Organizational Training	3
Supplier Agreement Management	2
Integrated Project Management	2
Organizational Process Focus	2
Organizational Process Definition	2
Quantitative Project Management	2
Causal Analysis And Resolution – Defect Prevention	2
Organizational Innovation And Deployment	2
Organizational Process Performance	2

3.4. The effect of Culture on Software Process Improvement (SPI)

Muller and others have investigated the effect of culture on SPI and how variations in culture across software firms may impact SPI outcomes. They stated in their article [Muller 2008] that it is important for managers in IT companies to consider the fit between values embedded in new processes and the context in which they are to be implemented and to take differences in values into account when western style SPI models are adopted in nations with quite different cultures.

Muller and others [Muller 2008] have also mentioned some examples for articles and researches that addressed the effect of culture on SPI such as:

- Phongpaibul Research: which stated that; to successfully improve software processes in Thailand, researchers and practitioners must appreciate the cultural context and tailor western style processes to Thai software development practices.

- Meier Research has also drawn attention to the need for management to take occupational cultures into account when planning technological innovation as conflicts may arise due to different mental models or cognitive representations of technology.

- Leidner Research concluded that “a good fit between the values embedded in a development process and the values that are part of the

organizational culture will lead to a successful and appropriate solution and, an easier one to implement.

3.5. Discussion and Conclusion

A number of software development process improvement models were developed for the use inside small firms were discussed in this chapter.

The researcher has noticed that the some of these models were designed for the use inside large firms especially CMMI and ISO. Other models such as QuickLocus, CMMFT, MoProSoft, ADEPT, SPISO, MPS.BR and COMPTISOFT were built based on CMM model as a customized versions tailored for small firms. Some of these models such as QuickLocus has been successfully applied and showed success in the area it was used in. However, there is no evidence that these models would succeed if they are applied in Palestinian software development firms because all of them were built such that they fit the country from which the information was gathered. For example, CMM Fast Track has been developed for the use of software development companies in Hon Kong, MoProSoft has been developed to be used by Mexican software development companies and COMPETISOFT was developed for Latin America software development companies. Moreover and as indicated earlier in the previous section, the culture context must be taken into consideration when applying western SPI models for the purpose of improving software processes successfully.

Accordingly, the researcher wanted to build a low-cost, easy to understand and easy to apply methodology that can offer small Palestinian software organizations with greater competitiveness and allow competing in the global software marketplace. This model will be tailored for small Palestinian software development companies based on the most recognized model around the world (CMMI) with help and feedback from small software development companies in Palestine. The model will be built based on CMMI V1.3 [SEI 2010] model. The Capability Maturity Model Integration (CMMI) has been chosen by the researcher because it is one of the most widely adopted models for evaluating, benchmarking, and improving software processes based on what numerous companies consider best practice [Muller 2008]. Moreover, According to Muller and others, CMMI has become a de facto standard for SPI [Muller 2008, Lawrence 2002]. In addition, Sivashankar and others, considered CMMI as a vehicle for SPI and one of the widely used models for SPI around the word [Sivashankar 2010].

3.6. Summary of the Chapter

In this chapter the reader has been introduced to most well known centers and initiatives focused on software process improvement in small and very small software firms around the world. A large number of universities, research centers, and associations from all over the world have proposed software process models dedicated to small firms. However, no one has been able to propose a unified solution that fits small software

development firms taking all previous experience and knowledge into account.

A number of software development process improvement models that were developed to small firms have been discussed. However, the provided frameworks are still too complicated and cannot be applied by small software firms.

Some of these models were compared based on origin, process areas included and then later in the chapter the culture impact on SPI was addressed.

Based on provided information and comparison made, the researcher has come to a conclusion that a special frame work for small Palestinian software development firms is required and this framework should be built and designed based on an input and information from these firms. A number of models were also selected to build the required model based on. These models have been chosen because they all were mainly built based on CMMI standard and CMMI is the most widely recognized model and has become the de facto standard for SPI.

Chapter 4
Research Methodology and Data Gathering

4.1. Introduction

This chapter aims to provide an overview of the methodological approach selected to design a process improvement framework for small Palestinian software development firms. It also describes how the research was conducted and how the results were received and gathered.

4.2. Research Methodology

This research aimed to have information about the software development process inside small Palestinian software development firms and get information about the key Process Areas that are currently being applied by these firms. Also, it aimed to got collect information about the key Process Areas that are considered most important for small software firms in order to enable them to deliver software products one time, first time, every time with least cost and with pleasing quality. This required collecting information from a number of small software development firms in Palestine.

According to Kohan [Kohan 2008], there are two main approaches for research; Quantitative approach and Qualitative one. While the Qualitative approach involves experimental and survey methods, the qualitative approach involves participant interviews, Research-action and case studies. According to Nakano and Fleury, “the experimental research and survey are the methods that are more frequently associated with the

quantitative research approach" [Kohan 2008]. According to Vasiljevic, the survey questionnaire is typical for a quantitative collection approach [Vasiljevic 2003].

As this research consists of categorized questions as will be explained in the next section (Section 4.3) and based on the information mentioned above and for the purposes of this research; a survey questionnaire was found to be appropriate to use in this research. This is also similar to the research approach that was adopted to design the SPISO model that was mentioned in chapter 3 (Literature Review).

4.3. Survey Questionnaire Design

This research has two main sections of questions; Participant Information section and Questionnaire Categories and Questions section. These sections aim to analyze the following information about small software development firms in Palestine:

1. Survey Participants' profiles.
2. Software development firm's profiles.
3. Key process areas that are currently being applied by small software firms.
4. Key process areas that are considered most important by small software firms.

These sections are explained as follows:

- Section One: this section aimed to have information about survey participants' profiles and to get a general view about the characteristics of software development firms in Palestine. It has four questions which were developed by the researcher in order to give information about the number of employees inside the software firms and some information about the employees profile such as experience, level of education and gender.
- Section Two: this section consisted of 47 questions that give the characteristics of software development process inside small Palestinian software development firms and aims to provide information about key Process Areas that are currently being applied by small software firms as well as the most important Process Areas based on small software firms' view. These questions were adapted from an empirical study conducted in Sweden after doing the following changes [Vasljevic 2003]:
  - Updating the whole survey questions based on specific goals for all key process areas contained on the latest version of CMMI (V1.3).
  - The process areas that were taken from ISO have been excluded from the survey.

In section two of the survey questionnaire, each question should be answered twice; the first is to what degree the activity is integrated within the software development process inside the participant company and the second is how important the activity is important for the participant company in order to help them producing high quality software products.

The language of the questions was English language. This was chosen because all software firms in Palestine have a wide knowledge in English language and are familiar with software terms in English language as well. Also, most of these firms use English language within their work and their internal communication.

In order to find out if there is any unclear question within the survey, all participants were asked not to answer the question/s which they do not understand and found unclear. These questions have been excluded from the analysis in order to increase the quality.

4.4. Testing the Questionnaire

Pilot test has been conducted on an organization within the population and the feedback received after interviewing the test participant was taken into consideration before sending the final survey and make it available for the participants. Also, an external expert has been asked to review the survey and his feedback has also been considered and taken into consideration. After that, every unclear question on the survey questionnaire has been updated before circulating the final version to the survey population sample.

4.5. Survey Population and Sampling Criteria

Research population was small Palestinian software development organizations that employ more than 2 employees and a maximum of 50 employees.

The definition of the population is described below:

- Palestinian software Development Company.
- Employ less than 50 employees.
- Supplier of software for local or international market.
- Have in-house development of software.

The majority of respondents were selected from Palestinian Information Technology Association (PITA) Members' webpage at PITA's website [PITA 2010]. The researcher have contacted all of these firms and asked them to participate in the survey. The selection for companies was made by selecting all companies that work in software development field according to criteria specified for the population.

An investigation was made to see if the companies selected fit into the criteria for participating in the survey. This was mainly done by visiting the WebPages of these companies and asking the participant to fill their information before start filling the questionnaire.

Only 18 out of 98 companies were selected according to specified criteria from PITA's webpage. Another 7 organizations were added because the researcher had a contact within these companies. Moreover, since Jordan is very close to Palestine and has the same culture and because the goal for the survey was to get at least 40 software development firms to participate in it and in order to have a representative sample of software

firms, another 15 software development companies have been added from Jordan. The majority of the selected firms from Jordan have offices in Palestine.

The 40 software firms that have been selected were sufficient enough to provide an indication of the current situation of the software development processes inside these firms and firm's view about the importance of the key Process Areas to their firms.

Each firm was contacted by phone where the purpose for the study was explained to the software project manager, IT manager or the head of software development inside these firms. If the firm agreed on participating, an email with a more detailed explanation about the study was send to the participant.

4.6. Data Collection Approach

The questionnaire was sent to 40 software firms by e-mail and 30 firms responded over four weeks. This represented a response rate of 75%.

The data for this survey was collected from 30 Palestinian small software development companies by sending emails with questionnaires directly to the company's IT director, head of IT, software development project manager, and senior software development professionals inside these firms.

4.7. Summary of the Chapter

A quantitative survey has been used in this research. The questionnaire was mainly consisted of two main sections of questions; Participant Information section and Questionnaire Categories and Questions section. These sections aimed to analyze information about small software development firms in Palestine and the information about current Process Areas that are being applied by these firms.

The majority of participants were selected from PITA's Website and informed about the study by phone and email. In order to increase the population size and in order to have a representative sample, the questionnaire population has been extended to a number of Jordanian firms.

The survey questionnaire has been tested on one company within the population and an external expert has been also asked to review the questionnaire before making it available for the participants. Also, information about how the research was conducted and how the results were received and gathered has been discussed in this chapter.

Chapter 5
Survey Results and Analysis

5.1 Introduction

The data for this research has been collected using online survey which was distributed to small software development firms in Palestine. In this chapter the results of the survey questionnaire will be presented. Then, they will be discussed and analyzed.

5.2. A general View about Survey Results

As noted earlier, the electronic survey was distributed to a number of small software development firms in Palestine which represent the main firms whose sizes were above 2 and below 50 employees.

The researcher had requested that at least 40 responses to be completed, in order to have an appropriate sample that satisfies the research requirements and objectives. During a period of five weeks, 30 surveys out of 40 were returned completed. This represents a response rate of 75%.

The results of the survey revealed the following:

- Around 64% of the participants employ less than 10 employees inside their firms and these firms are dominated by males where less than 57% of the employees have less than 5 years of experience. Also, 8 of the 30 respondents have a master degree where only one of them has a PhD degree.

- Regarding the current situation of key process areas inside small software firms, the results revealed that none of the Process Areas was strongly agreed by the participants that it is implemented inside their software firms and also none of the Process Areas was strongly disagreed that it is not implemented inside their firms.

- The results also showed that when it comes to the importance of the key Process Areas included in the survey for small firms, all participants have agreed that all of the process areas are important for their firms to succeed in delivering high quality software products.

5.3. Presentation of Research Results

The objectives of the survey were to get a general view about participants' profiles inside small software firms, investigate to what extent the sample companies are implementing key Process Areas within their software development processes and to get their view on the importance of these key Process Areas to their firms; the obtained results will be presented in the following sections.

5.3.1. Participants' Profiles in small software firms

The first section of the survey questionnaire contained five questions that aimed to have a general view about participants' profiles in small software development firms in Palestine as well as the number of employees inside their firms. The questions and results were as follows:

- **What is the number of employees inside your firm?**

Figure 4-1 presents the results of this question. The answers of this question view the number of employees inside small Palestinian software firms. Depending on the answers received from participants, the researcher noticed that around 50% of the participants employ less than 10 employees and this is the largest percentage who responded to the questionnaire. Also, around 10% of the participated companies employ more than 10 and less than 20 employees while around 40% of the participants employ more than 20 employees.

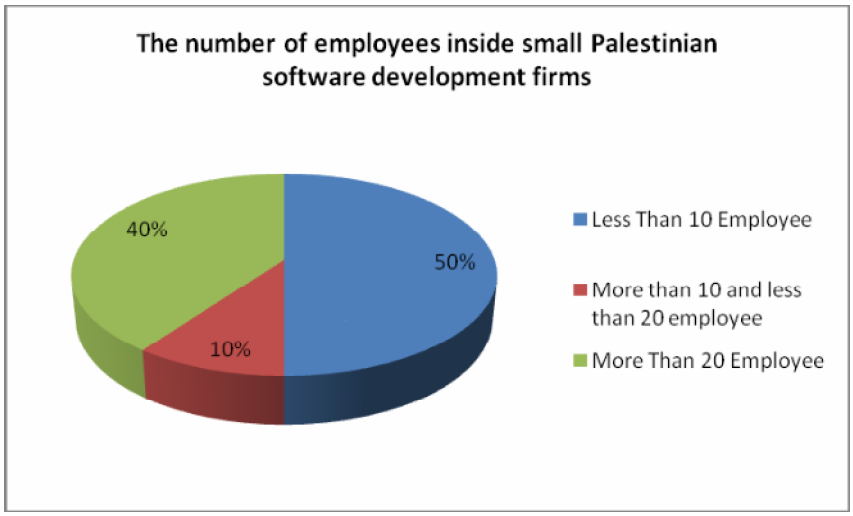

Figure (5-1): The number of employees inside small Palestinian software development firms.

- **What is your gender?**

93% of the participants were males and only 7% of them were females. Based on this result, we can conclude that small Palestinian software firms are dominated by males.

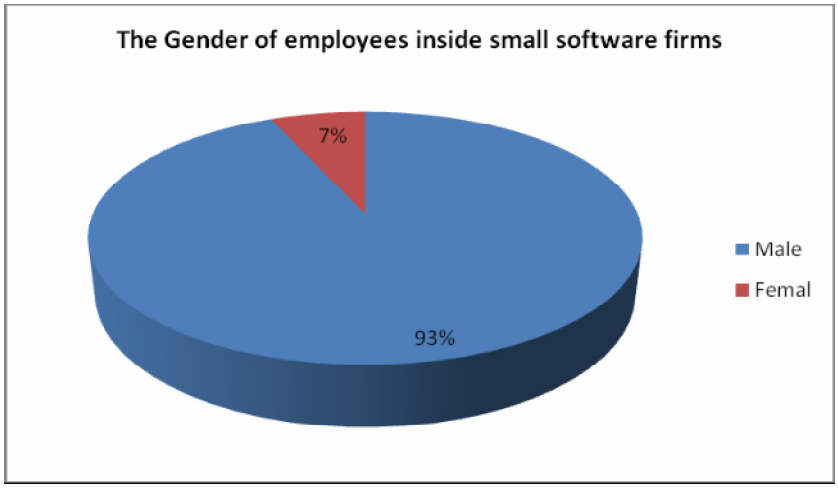

Figure (5-2): the gender of participants' inside small Palestinian software development firms.

- **For how long you are working in software development?**

Figure 4-3presents the result of this question. Depending on the result of this question, we can conclude that 60% of the survey's respondents have more than 10 years of experience in software development field and around 40% of employees have less than five years of experience in the software development.. This refers to the maturity of the participants who responded to the survey questionnaire.

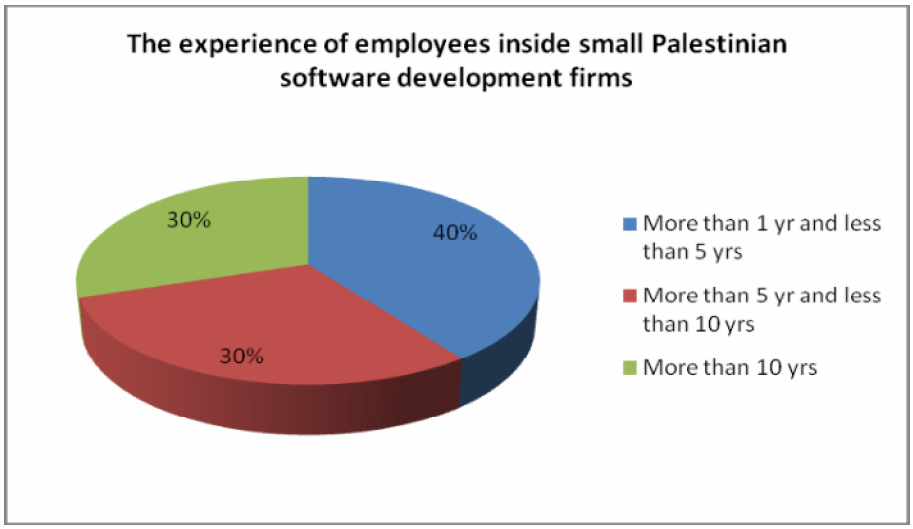

Figure (5-3): the experience of survey's participants inside small Palestinian software development firms.

- **What is your level of education?**

The result of this question refers to the high ratio of the employees who have a bachelor degree which is represented by 70% of the participants while 27% of the participants have a master degree and only 3% hold a PhD degree. This also refers to the maturity of the participants who responded to the survey questionnaire.

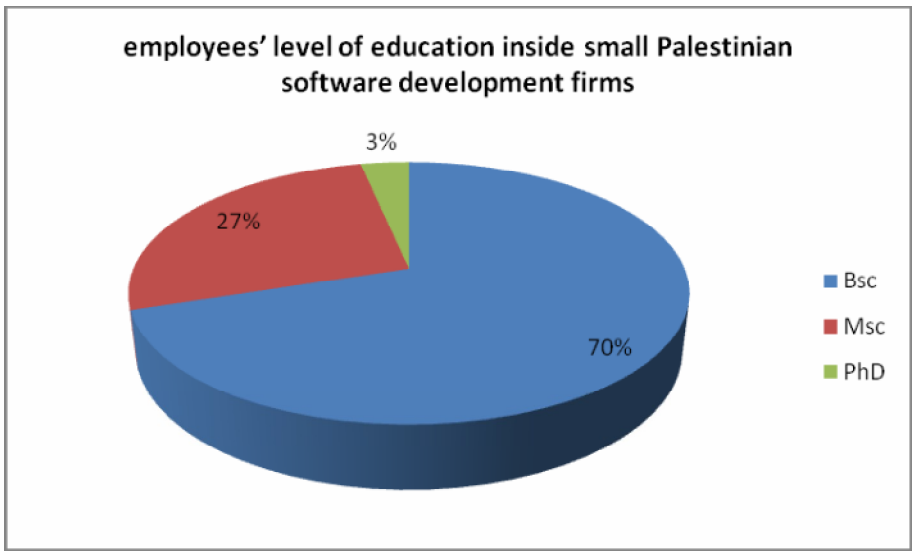

Figure (5-4): participants' level of education inside small Palestinian software development firms.

5.3.2. Current Situation of Software Development Process

Table 5-1 presents the results of the first question of the second section of the survey which was to what extent software development firms implement key process areas within their software development process/s.

Table (5-1): Current Situation of Software Development Process. Average result for each question and Process Area

Process Areas/Questions	Avg. Implemented
1. Requirements Management	
Question 1 - Manage Requirements - Requirements are managed and inconsistencies with project plans and work products are identified.	
2. Project Planning	
Question 2 - Establish Estimates - Estimates of project planning parameters are established and maintained.	
Question 3 - Develop a Project Plan - A project plan is established and maintained as the basis for managing the project.	
Question 4 - Obtain Commitment to the Plan - Commitments to the project plan are established and maintained.	
3. Supplier Agreement Management	
Question 5 - Establish Supplier Agreements - Agreements with the suppliers are established and maintained.	
Question 6 - Satisfy Supplier Agreements - Agreements with the suppliers are satisfied by both the project and the supplier.	
4. Measurement And Analysis	
Question 7 - Align Measurement and Analysis Activities - Measurement objectives and activities are aligned with identified information needs and objectives.	
Question 8 - Provide Measurement Results - Measurement results that address identified information needs and objectives are provided.	
5. Process And Product Quality Assurance	
Question 9 - Objectively Evaluate Processes and Work Products - Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated.	
Question 10 - Provide Objective Insight - Noncompliance issues are objectively tracked and communicated, and resolution is ensured.	
6. Configuration Management	

Question 11 - Establish Baselines - Baselines of identified work products are established.	
Question 12 - Track and Control Changes - Changes to the work products under configuration management are tracked and controlled.	
Question 13 - Establish Integrity -Integrity of baselines is established and maintained.	
7. Requirements Development	
Question 14 - Develop Customer Requirements - Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.	
Question 15 - Develop Product Requirements - Customer requirements are refined and elaborated to develop product and product-component requirements.	
Question 16 - Analyze and Validate Requirements - The requirements are analyzed and validated, and a definition of required functionality is developed.	
8. Technical Solution	
Question 17 - Select Product-Component Solutions - Product or product-component solutions are selected from alternative solutions.	
Question 18 - Develop the Design - Product or product-component designs are developed.	
Question 19 - Implement the Product Design - Product components, and associated support documentation, are implemented from their designs.	
9. Product Integration	
Question 20 - Prepare for Product Integration - Preparation for product integration is conducted.	
Question 21 - Ensure Interface Compatibility - The product-component interfaces, both internal and external, are compatible.	
Question 22 - Assemble Product Components and Deliver the Product - Verified product components are assembled and the integrated, verified, and validated product is delivered.	
10. Verification	
Question 23 - Prepare for Verification - Preparation for verification is conducted.	
Question 24 - Perform Peer Reviews - Peer reviews are performed on selected work products.	

Question 25 - Verify Selected Work Products - Selected work products are verified against their specified requirements.	
11. Validation	
Question 26 - Prepare for Validation - Preparation for validation is conducted.	
Question 27 - Validate Product or Product Components - The product or product components are validated to ensure that they are suitable for use in their intended operating environment.	
12. Organizational Process Focus	
Question 28 - Determine Process-Improvement Opportunities - Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.	
13. Organizational Process Definition	
Question 29 - Plan and Implement Process-Improvement Activities - Improvements are planned and implemented, organizational process assets are deployed, and process-related experiences are incorporated into the organizational process assets.	
Question 30 - Establish Organizational Process Assets - A set of organizational process assets is established and maintained.	
14. Organizational Training	
Question 31 - Establish an Organizational Training Capability - A training capability that supports the organization's management and technical roles is established and maintained.	
Question 32 - Provide Necessary Training - Training necessary for individuals to perform their roles effectively is provided.	
15. Integrated Project Management	
Question 33 - Use the Project's Defined Process - The project is conducted using a defined process that is tailored from the organization's set of standard processes.	
Question 34 - Coordinate and Collaborate with Relevant Stakeholders - Coordination and collaboration of the project with relevant stakeholders is conducted.	
16. Risk Management	
Question 35 - Prepare for Risk Management -	

Preparation for risk management is conducted.	
Question 36 - Identify and Analyze Risks - Risks are identified and analyzed to determine their relative importance.	
Question 37 - Mitigate Risks - Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.	
17. Decision Analysis And Resolution	
Question 38 - Evaluate Alternatives - Decisions are based on an evaluation of alternatives using established criteria.	
18. Organizational Process Performance	
Question 39 - Establish Performance Baselines and Models - Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.	
19. Quantitative Project Management	
Question 40 - Quantitatively Manage the Project - The project is quantitatively managed using quality and process-performance objectives.	
Question 41 - Statistically Manage Subprocess Performance - The performance of selected subprocesses within the project's defined process is statistically managed.	
20. Causal Analysis And Resolution	
Question 42 - Determine Causes of Defects - Root causes of defects and other problems are systematically determined.	
Question 43 - Address Causes of Defects - Root causes of defects and other problems are systematically addressed to prevent their future occurrence.	
21. Organizational Performance Management	
Question 44 - Aggregated project data is iteratively analyzed	
Question 45 - Gaps in performance against the business objectives are identified	
Question 46 - Improvements to close the gaps are selected and deployed	
22. Project Monitoring and Control	
Question 47 - Appropriate corrective actions can be taken when the project's performance deviates significantly from the plan	

5.3.3. Small Software Firms View on the Importance of Key Process Areas

Table 5-2 presents the results of the second question of the second section of the survey which represented to what extent small software development firms consider key Process Areas important for their firms to succeed in delivering high quality software products.

Table (5-2): Importance of key Process Areas for small software firms. (Average result for each question and Process Area)

Categories/Questions	Avg. Important
1. Requirements Management	
Question 1 - Manage Requirements - Requirements are managed and inconsistencies with project plans and work products are identified.	
2. Project Planning	
Question 2 - Establish Estimates - Estimates of project planning parameters are established and maintained.	
Question 3 - Develop a Project Plan - A project plan is established and maintained as the basis for managing the project.	
Question 4 - Obtain Commitment to the Plan - Commitments to the project plan are established and maintained.	
3. Supplier Agreement Management	
Question 5 - Establish Supplier Agreements - Agreements with the suppliers are established and maintained.	
Question 6 - Satisfy Supplier Agreements - Agreements with the suppliers are satisfied by both the project and the supplier.	
4. Measurement And Analysis	
Question 7 - Align Measurement and Analysis Activities - Measurement objectives and activities are aligned with identified information needs and objectives.	
Question 8 - Provide Measurement Results - Measurement results that address identified information needs and objectives are provided.	
5. Process And Product Quality Assurance	
Question 9 - Objectively Evaluate Processes and Work Products - Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated.	
Question 10 - Provide Objective Insight - Noncompliance issues are objectively tracked and communicated, and resolution is ensured.	
6. Configuration Management	

Question 11 - Establish Baselines - Baselines of identified work products are established.	
Question 12 - Track and Control Changes - Changes to the work products under configuration management are tracked and controlled.	
Question 13 - Establish Integrity -Integrity of baselines is established and maintained.	
7. Requirements Development	
Question 14 - Develop Customer Requirements - Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.	
Question 15 - Develop Product Requirements - Customer requirements are refined and elaborated to develop product and product-component requirements.	
Question 16 - Analyze and Validate Requirements - The requirements are analyzed and validated, and a definition of required functionality is developed.	
8. Technical Solution	
Question 17 - Select Product-Component Solutions - Product or product-component solutions are selected from alternative solutions.	
Question 18 - Develop the Design - Product or product-component designs are developed.	
Question 19 - Implement the Product Design - Product components, and associated support documentation, are implemented from their designs.	
9. Product Integration	
Question 20 - Prepare for Product Integration - Preparation for product integration is conducted.	
Question 21 - Ensure Interface Compatibility - The product-component interfaces, both internal and external, are compatible.	
Question 22 - Assemble Product Components and Deliver the Product - Verified product components are assembled and the integrated, verified, and validated product is delivered.	
10. Verification	
Question 23 - Prepare for Verification - Preparation for verification is conducted.	
Question 24 - Perform Peer Reviews - Peer reviews are performed on selected work products.	

Question 25 - Verify Selected Work Products - Selected work products are verified against their specified requirements.	
11. Validation	
Question 26 - Prepare for Validation - Preparation for validation is conducted.	
Question 27 - Validate Product or Product Components - The product or product components are validated to ensure that they are suitable for use in their intended operating environment.	
12. Organizational Process Focus	
Question 28 - Determine Process-Improvement Opportunities - Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.	
13. Organizational Process Definition	
Question 29 - Plan and Implement Process-Improvement Activities - Improvements are planned and implemented, organizational process assets are deployed, and process-related experiences are incorporated into the organizational process assets.	
Question 30 - Establish Organizational Process Assets - A set of organizational process assets is established and maintained.	
14. Organizational Training	
Question 31 - Establish an Organizational Training Capability - A training capability that supports the organization's management and technical roles is established and maintained.	
Question 32 - Provide Necessary Training - Training necessary for individuals to perform their roles effectively is provided.	
15. Integrated Project Management	
Question 33 - Use the Project's Defined Process - The project is conducted using a defined process that is tailored from the organization's set of standard processes.	
Question 34 - Coordinate and Collaborate with Relevant Stakeholders - Coordination and collaboration of the project with relevant stakeholders is conducted.	
16. Risk Management	
Question 35 - Prepare for Risk Management - Preparation for risk management is conducted.	

Question 36 - Identify and Analyze Risks - Risks are identified and analyzed to determine their relative importance.	
Question 37 - Mitigate Risks - Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.	
17. Decision Analysis And Resolution	
Question 38 - Evaluate Alternatives - Decisions are based on an evaluation of alternatives using established criteria.	
18. Organizational Process Performance	
Question 39 - Establish Performance Baselines and Models - Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.	
19. Quantitative Project Management	
Question 40 - Quantitatively Manage the Project - The project is quantitatively managed using quality and process-performance objectives.	
Question 41 - Statistically Manage Subprocess Performance - The performance of selected subprocesses within the project's defined process is statistically managed.	
20. Causal Analysis And Resolution	
Question 42 - Determine Causes of Defects - Root causes of defects and other problems are systematically determined.	
Question 43 - Address Causes of Defects - Root causes of defects and other problems are systematically addressed to prevent their future occurrence.	
21. Organizational Performance Management	
Question 44 - Aggregated project data is iteratively analyzed	
Question 45 - Gaps in performance against the business objectives are identified	
Question 46 - Improvements to close the gaps are selected and deployed	
22. Project Monitoring and Control	
Question 47 - Appropriate corrective actions can be taken when the project's performance deviates significantly from the plan	

5.4. Data Analysis

Microsoft excel was used to aggregate the results for all respondents and to calculate the average values for each question and Process Area.

The results of the first and second questions have been analyzed according to following scales, which are based on conventional mathematical rounding rules:

Table (5-3): Scales for Section 2 of Survey Questions.

First Question Scale		Second Question Scale	
Strongly disagree	0.00-1.49	Strongly disagree	0.00-0.25
Disagree	1.50-2.49	Disagree	0.26-0.49
Neutral	2.50-3.49	Neutral	0.50-0.74
Agree	3.50-4.49	Agree	0.75-0.90
Strongly agree	4.50-5.00	Strongly agree	0.91-1.00

The reason why the researcher decided that participants answer the second question with Yes/No; is to simplify the survey and allow the participants answering questions with least time.

5.4.1. Analysis of the Process Areas

As mentioned earlier in chapter 4, there were a total of 22 Process Areas included in the questionnaire. Daniel Vasiljevic has come to a conclusion about Key software Process Areas and divided them into two families [Vasiljevic 2003]:

- **Software Process Areas Family**: this family includes processes that are good software processes and followed to develop the software products.

- **Process Improvement Areas Family**: this family includes processes that improve the software Processes Areas that don't meet the expectations.

According to this conclusion, Table 5-4 includes the Software Improvement Process Areas which represent 5 out of the 22 Process Areas where the other 17 Process Areas are belonging to the Software Process Areas family.

Table (5-4): The five Process Areas belonging to process improvement.

Categories	Purpose
1 - Measurement and Analysis	The purpose of Measurement and Analysis is to develop and sustain a measurement capability that is used to support management information needs.
2 - Organizational Process Focus	The purpose of Organizational Process Focus is to plan and implement organizational process improvement based on a thorough understanding of the current strengths and weaknesses of the organization's processes and process assets.
3 - Organizational Process Performance	The purpose of Organizational Process Performance is to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.
4 - Quantitative Project Management	The purpose of the Quantitative Project Management process area is to quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.
5 – Organization Performance Management	The purpose of Organizational Performance Management is to proactively manage the organization's performance to meet its business objectives.

Source (Vasiljevic 2003).

5.4.2. Analysis of Current Situation of Software Development Process

One of the objectives of this research is to find out how small software firms implement Key Process Areas within their software development process. Table 5-5 presents a summary of the survey results sorted by average value of each Process Area in descending order.

Table (5-5): Summary of the results by Process Area sorted by average value for each Process Area

Category	Avg. Implemented
Validation	4.04
Requirements Management	3.93
Requirements Development	3.90
Project Planning	3.85
Product Integration	3.74
Causal Analysis And Resolution	3.71
Process And Product Quality Assurance	3.64
Project Monitoring and Control	3.50
Technical Solution	3.50
Verification	3.46
Configuration Management	3.40
Organizational Training	3.39
Decision Analysis And Resolution	3.36
Supplier Agreement Management	3.36
Risk Management	3.29
Integrated Project Management	3.29
Measurement And Analysis	3.13
Organizational Performance Management	2.90
Quantitative Project Management	2.81
Organizational Process Focus	2.79
Organizational Process Definition	2.72
Organizational Process Performance	2.64

By looking at table 5-5, we can conclude the followings:

- None of the Process Areas was strongly agreed by the participants that it is currently being implemented inside their firms. And also none of

the Process Areas was strongly disagreed that it is currently not being implemented.

- The results of the survey questionnaire have revealed that participants agreed that Validation, Requirements Management, Requirements Development, Project Planning, Product Integration, Project Monitoring and Control, Causal Analysis and Resolution - Defect Prevention, Process and Product Quality Assurance and Technical Solution Process Areas are being implanted inside their firms.

- Process Improvement Areas (Organizational Performance Management, Organizational Process Focus, Organizational Process Performance, Measurement and Analysis and Quantitative Project Management) have been identified as the least implemented Process areas inside small software firms where they have got a result of 3.13 and below with minim result of 2.64 for Organizational Process Performance Process Area.

5.4.3. Analysis of Small Software Firms View on the importance of Key Process Areas to their firms

The second objective of the survey was to have small software development firms' view on the importance of key Process Areas for their firms to succeed in delivering high quality software products. This section will discuss the answers from participated firms and analyze their view about this issue. Table 5-6 presents a summary of the results of the key

Process Areas that were included in the survey and sorted according to average importance of each Process Area.

Table (5-6): The results of the importance of Process for small firms sorted by average importance

Process Area	Avg.
Requirements Management	1.00
Requirements Development	0.97
Project Planning	0.95
Project Monitoring and Control	0.92
Organizational Training	0.90
Validation	0.82
Product Integration	0.82
Technical Solution	0.81
Causal Analysis And Resolution - Defect Prevention	0.81
Supplier Agreement Management	0.78
Organizational Performance Management	0.77
Organizational Process Focus	0.77
Organizational Process Performance	0.77
Process And Product Quality Assurance	0.74
Measurement And Analysis	0.72
Risk Management	0.72
Configuration Management	0.70
Verification	0.70
Decision Analysis And Resolution	0.69
Integrated Project Management	0.65
Quantitative Project Management	0.63
Organizational Process Definition	0.51

By looking at table 5-6, we can conclude that the followings:

- All Process Areas have got a response above 0.50 which means that all Process Areas are considered important for small software development firms. This result does not comply with the researcher's expectations.

- Requirements Management Process Area has got a response of 1; which means that all respondents have strongly agreed that this category is important for small software development firms to succeed in delivering high quality software products. This result complies with the researcher's expectations.

- Requirements Development, Project Planning, Project Monitoring and Control and Organizational Training have got a response of 0.9 and above and are indicated along with Requirements Management as the most important Process Areas for small software firms.

- Decision Analysis and Resolution, Integrated Project Management, Quantitative Project Management and Organizational Process Definition Process Areas were indicated as the least important process areas for small software firms. However, they have got a response of 0.5 and above. This means that these Process Areas were considered important for small software development firms. This result is also does not comply with the researcher's expectations.

- Process Improvement Areas (Organizational Performance Management, Organizational Process Focus, Organizational Process Performance, Measurement and Analysis and Quantitative Project Management) have got a response of 0.63 and above with highest response of 0.77 for Organizational Performance Management process area. This means that these Process Areas are considered important for small software firms and will also be considered in the output

model. This results shows that small software firms are aware of the importance of these Process Areas to their firms.

5.5. Results of the survey and the need for SPI model

As determined from the foregoing, the survey exposed the situation of the key process areas for software development life cycle and small software firms view about the importance of these Process Areas to their firms. The respondents agreed that all Process Areas are important for their firms and indicated that only part of them is implemented inside their firms. For example, Process Improvement Areas have been identified as the least implemented Process Areas where they have also been identified as an important Process Areas for small software firms to succeed in delivering high quality software products. Consequently, there is a need to develop a process improvement framework that is tailored for small Palestinian software development firms in order to enable them to assess their current software processes, determine the areas that need improvement and provide them with clear plan for improvement in order to become a mature software development firms.

5.6. Comparing the Results with Theory and Literature

5.6.1. Comparing the Results with Jordanian Small Firms

The results of the survey indicated that most of Palestinian software development firms do not have long experience in software development field. This result is similar to the result of the survey conducted by Mejhem

and others on Jordanian small software firms [Mejhem 2009]. The conclusion that can be drawn from this point is that both Palestinian and Jordanian firms are dominated by employees with less than five years of experience and this refers to the modernity of software development sector in Palestine and Jordan.

The results of the survey have also justified the need for a process improvement framework that it is tailored for small software firms. This result is also aligned with the result that was concluded by Mejhem and others regarding small Jordanian software firms where they have concluded that “the Jordanian small software development firms need to have suitable software process improvement framework to manage and improve their software processes that enable these firms to implement the suitable SPI” [Mejhem 2009]. This result is also aligned with theory and literature [Vasiljevic 2003, Mondragon, 2006; Revankar, Mithare, Nallagonda, 2006 & Mejhem 2009] which indicated that small software companies tend to stick with the defined software processes inside the organization, without measuring and improving them and they often lack the experience to conduct process improvement [Leung 2008].

5.6.2. The Most Important Process Areas

All participants agreed that Requirements Management is the most important Process Area for their firms. This result is aligned with theory and literature as this Process Area was found in 4 out of the 6 compared models in chapter three. This result is also aligned with the researcher’s expectations.

Project Monitoring and Control was one of the most important Process areas that were identified by the participants. This Process Area was also found in all of the 6 compared models in chapter three (for more information, please refer to chapter 3).

Both Requirements Development and Project Planning Process Areas have also been identified as of most importance for small software firms and these Process Areas where found on 5 out of the 6 compared models in chapter three. Table 5-7 presents the top most important Process Areas that have been identified by the participants and the number of models each them found in the compared models in chapter 3 (for more information, please refer to chapter 3).

Table(5-7): Top 5 important Process Areas and the models available in

Process Area	Importance	No. of models available in
Requirements Management	100%	4
Requirements Development	97 %	5
Project Planning	95 %	5
Project Monitoring and Control	92 %	6
Organizational Training	90 %	3

5.6.3. Comparing the Results with SPISO Model Research Results

Since this research was highly depended on similar research that was conducted on small Swedish software firms, it is interesting to compare the results achieved through this research with the results achieved in it. In both surveys, all respondents agreed that all Process Areas important for small software firms. Also, Both studies have prioritized the process improvement Areas as of least important for small software firms.

5.7. Summary of the Chapter

The results of the survey were presented and analyzed. The survey was distributed to 40 software development firms in Palestine who employee less than 50 employees. Over a period of 5 weeks, 40 completed forms were returned which represented a response rate of 75%.

All of the participants have agreed that all Process Areas that were included in the survey are important for small software firms. This result was aligned with similar researches conducted in Jordan and Sweden.

Process Improvement Areas were considered important and least implemented inside small software firms. This result justified the need for process improvement framework that is tailored for small software firms in Palestine.

Chapter 6
The Model

6.1 Introduction

The purpose of this chapter is to describe the model the researcher has designed based on the results of the survey and the comparison made in the literature review (chapter 3). First a description, scope and foundation of the model will be discussed. Secondly, the architecture of the model will be presented. Third, scales used in the proposed model will be described. And finally a detailed description about how the proposed model was designed will be mentioned.

6.2. PAL-SPI Model Description, Scope and Foundation

The researcher has decided to name the proposed model “PAL-SPI” which stands for Software Process Improvement for Small Palestinian Software Firms.

PAL-SPI is a framework that could be applied by small Palestinian software development firms to identifying the current status of their software processes and find key Process Areas that need improvement.

PAL-SPI-Model is mainly based on a combination of models that were designed for small software development firms in some countries around the world. These models (SPISO, CMM FT, ADEPT, EPA, RAPID and MPS.BR Model) were presented and compared in chapter 3. (For more information about these models, please refer to chapter 3). In addition,

PAL-SPI model is designed based on a survey questionnaire that was conducted on small software development firms in Palestine in order to have small software firms' view about important key Process Areas for their firms to succeed in delivering high quality software products.

The architecture of PAL-SPI model has been proposed in order to fit small software development firms in Palestinian. The PAL-SPI-model architecture is closely related to the structure of SPISO framework [Vasljevic 2003] where point scale is used to determine the maturity level of the software development firm. In order to achieve a maturity level, software firm needs to implement various Process Areas where each Process Area contains a number of activities that are implanted to achieve certain goals. The higher number of points achieved, the higher the maturity of the firm is.

The PAL-SPI model includes all Process Areas that were considered important for small software firms and found in three or more of the compared models in chapter three. A detailed description on how the model was designed is coming in the following sections. Figure 6-1(Architecture of PAL-SPI model) presents the main architecture of PAL-SPI models.

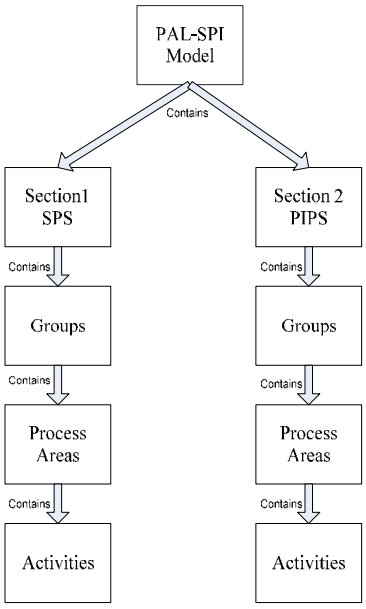

Figure (6-1): Architecture of PAL-SPI model

6.3. PAL-SPI Model Sections' Description

PAL-SPI framework consists of the following two main sections:

6.3.1. Software Processes Section (SPS):

This section can be used by small software firms in Palestine to make self assessment for their software development processes and find areas to improve. This section consists of 3 groups where each group contains four Process Areas. The Groups and Process Areas are presented in Table 6-1.

Table (6-1): Groups and Process Areas belonging to Software Process Areas Section

Group	Process Area
Group1	Requirements Management (RM)
	Requirements Development (RD)
	Project Planning (PP)
	Project Monitoring and Control (PM&C)
Group2	Organizational Training (OT)
	Validation (Val.)
	Product Integration (PI)
	Technical Solution (TS)
Group3	Process And Product Quality Assurance (P&PQA)
	Risk Management (Rs.M)
	Configuration Management (CM)
	Verification (Ver.)

6.3.2. Process Improvement Processes Section (PIPS):

This section consists only of one group that contains the Process Improvement Areas family. This section is used to help small software development firms to implement a continuous software process improvement program inside their firms. The Process Areas contained in this group are listed in Table 6-2.

Table (6-2): Process Areas belonging to Process Improvement Areas Section

Group	Process Areas
Group 4	Organizational Performance Management (OPM)
	Organizational Process Focus (OPF)
	Organizational Process Performance (OPP)
	Measurement And Analysis (M&A)
	Quantitative Project Management (QPM)

As described earlier, the two sections consist of Group/s where each group consists of a number of Process Areas. Each process Area consists of a number of activities that are implemented in order to achieve certain goals.

Figure 6-2 presents PAL-SPI model with its main Sections, Groups and Process Areas:

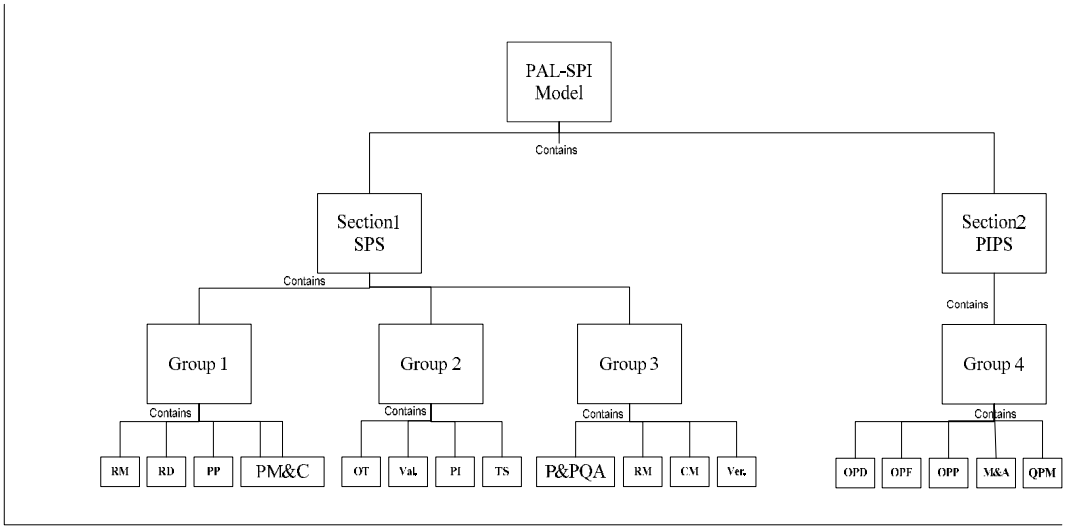

Figure 6.3.2-2): PAL-SPI model; Sections, Groups and Process Areas

6.4. PAL-SPI Model Scales

As used in SPISO model, PAL-SPI uses two different scales; the point scale and the maturity scale.

6.4.1. The Point Scale

The Point scale was used in designing SPISO model and is also used to measure where the software development firm is located on PAL-SPI model. Using the Point Scale, each implemented Process Area worth a number of points based on the group in which it is located.

Using the Point Scale, each implemented Process Area will always be considered when measuring maturity. According to Daniel Vasljevic and others, Point Scale allows having a faire picture of the actual maturity

of the software firm. Daniel explained in his thesis that “If looking at SW-CMM for example an organization could theoretically have implemented all Process Areas on all levels but one on level 2 and would still be rated to maturity level 1” and this is the reason why the researcher has decided to use Point Scale for the PAL-SPI model.

The golden rule of the Point Scale is; implementing all process Areas in one Group is worth to implementing all of the process areas in the previous group [Vasljevic 2003] and in order to earn points for each Process Area, all of the activities under that category must be implemented. Based on this rule and starting with 1 point for each Process Area in Group 3, each implemented Process Area in Group 3 is worth to 1 point where implementing one Process area of Group 2 is worth to implementing all Process Areas in Group 3. The same is applied for process areas in Group 1; implementing any of process areas in this group is worth to implementing all Process Areas in Group 2. Table 6-4 presents the Process Areas belonging to Software Processes Section along with the number of points each implemented Process Area worth in PAL-SPI model.

Table (6-3): Software Processes Section divided into 3 Groups.

Group	Process Area	No. of Points
Group1 (16 point / implemented category)	Requirements Management	16
	Requirements Development	16
	Project Planning	16
	Project Monitoring and Control	16
Group2 (4 point / implemented category)	Organizational Training	4
	Validation	4
	Product Integration	4
	Technical Solution	4
Group3 (1 point / implemented category)	Process And Product Quality Assurance	1
	Risk Management	1
	Configuration Management	1
	Verification	1

Based on above information, the following scale was established:

Table (6-4): The points needed to reach each level.

Level	Points needed
Level 0	0- 63 Points
Level 1	64-79 Points
Level 2	80-83 Points
Level 3	84 Points

6.4.2. The Maturity Scale

In order to express the maturity of software development firm, PAL-SPI model uses 4 maturity levels from zero to three and an additional maturity level four for process improvement. This is also the same scale that was used for designing SPISO model. However, Maturity levels have been adjusted according to survey results and the criteria of considering Process Areas in PAL-SPI model. this will be explained in the following section.

Unlike CMMI, Both the maturity scales in the PAL-SPI and SPISO models do not require all Process Areas on a level to be implemented in order to achieve that level of maturity.

6.5. How PAL-SPI Model Was Designed

The PAL-SPI model was designed based on the survey questionnaire results that were conducted on small software development firms in Palestine as well as the result of the comparison made earlier in chapter 3. In this section, detailed description on how this model was designed and the criteria used for considering each of its components are discussed.

6.5.1. How the Process Areas were selected and Grouped

The following criteria have been used to consider the Process Area of being part of PAL-SPI:

1. All Process Improvement Processes have been considered in the model because they are the heart of any SPI program and must be existed within any SPI initiative [Vasljevic 2003]. These Process Areas have been placed at a separate section of PAL-SPI model which is the Software Processes Section (SPS).

2. The Process Area must be considered important for small firms and had a result of 0.50 and above in the survey questionnaire.

3. The Process Area must be existing in 3 and above of the compared models (SPISO, CMM FT, ADEPT, EPA, RAPID and MPS.BR Model) in chapter three.

Based on the above criteria, there is 22 Process Areas included in the survey questionnaire. The five Process Areas relating to process improvement have been moved into separate section which is the Software Processes Section (SPS).

All of the other 17 remaining Process Areas achieved a result of 0.50 and above and considered important by small software firms to enable them in delivering high quality software products. However, only 12 of them were found in three out of the six compared models (SPISO, CMM FT, ADEPT, EPA, RAPID and MPS.BR Model). Table 6-5 presents the selected Process Areas after applying the mentioned criteria along with the aggregated result for each and the frequency each of them appears in the compared models.

Table (6-5): The 12 Process Areas after applying PAL-SPI model criteria

Process Area	Avg.	Freq.
Requirements Management	1.00	4
Requirements Development	0.97	5
Project Planning	0.95	5
Project Monitoring and Control	0.92	6
Organizational Training	0.90	3
Validation	0.82	4
Product Integration	0.82	3
Technical Solution	0.81	4
Process And Product Quality Assurance	0.74	5
Risk Management	0.72	5
Configuration Management	0.70	6
Verification	0.70	4

Then, the 12 Process Areas have been grouped based on their importance where they have been divided into three equal groups with four

Process Areas in each. Table 6-6: presents the four main groups of PAL-SPI Model along with their Sections and Process Areas.

Table (6-6): PAL-SPI Model Groups with their Process Areas

	Group	Process Area
Section1	Group1	Requirements Management
		Requirements Development
		Project Planning
		Project Monitoring and Control
	Group2	Organizational Training
		Validation
		Product Integration
		Technical Solution
	Group3	Process And Product Quality Assurance
		Risk Management
		Configuration Management
		Verification
Section 2	Group4	Measurement And Analysis
		Organizational Process Definition
		Organizational Process Performance
		Organizational Performance Management
		Quantitative Project Management

6.5.2. How the Point Scale was created

As mentioned earlier in section 6.4.1, a defined number of points are needed to reach a maturity level. The researcher defined the numbers of points needed to reach each level by summing all categories points in each group (see Table 6-4). For example: To reach level one at least 64 points (4*16) are needed, to reach level two, more than 64 points and less than 80 points are needed while to reach maturity level three 84 points are needed.

6.5.3. How Activities were developed

As mentioned earlier, each Process Area consists of a number of activities that need to be implemented in order to achieve the number of

points relating the process area. The set of activities in the PAL-SPI-Model were placed in the model using All “Specific Practices” from SPISO model and after updating them based on CMMI V1.3.

6.6. Summary of the Chapter

The PAL-SPI-Model is primarily aimed for software process improvement in small software development firms with less than fifty employees.

PAL-SPI consists of two different sections; the Software Processes Section (SPS) and the Process Improvement Processes Section (PIPS). SPS can be used by small software firms to make self assessment for their software development processes and find areas to improve. PIPS Section 2 is used to help software development firms to implement a continuous software process improvement program. Each section is consisted of Groups were each Group is consisted of a number of Process Areas. Each Process Area is consisted of a number of activities that must be implemented in order to earn the Process Areas’ points in the PAL-SPI scale.

PAL-SPI model uses point scale to measure the maturity of the software firms. The point scale is divided into four maturity levels where a number of defined points are required to reach each level.

Chapter 7
Conclusion and Recommendations

7.1. Introduction

This chapter provides a conclusion about the results of the thesis and presents how this research achieved its objectives and answered its questions. It will also present how this research contributed to the domain and provides recommendations and suggestions for future work in this field.

7.2. Discussion and Conclusion

The main objective for this research was to develop a software process improvement model that is tailored for small Palestinian software development firms. The desired model aimed to enable small software firms to assess their current software development processes and find areas that need improvement.

An empirical study was conducted using a survey questionnaire on small software firms in Palestine in order to get their view on the importance of key Process Areas relating to software process development.

The conclusion made from the results of the survey, was that all of the key Process Areas are considered important for small software firms to succeed in delivering highly quality software products. Also, the results indicated that the Process Areas relating to software process improvement have also been considered important for small firms although they have been prioritized as of least importance if they compared to other software

development Process Areas. Moreover, the survey's respondents have strongly agreed that the following Process Areas are the top most important ones for small software firms:

- Requirements Management
- Requirements Development
- Project Planning
- Project Monitoring and Control
- Organizational Training

Based on the survey results and the results of the compared models (SPISO, CMM FT, ADEPT, EPA, RAPID and MPS.BR Model) in chapter three and with the purpose of designing a simplified SPI framework that could be applied by small software firms in Palestine with less than fifty employees, the PAL-SPI Model was designed.

The PAL-SPI model consisted of two main sections. While the software development Process Areas were grouped and prioritized to form the first section of the model, the Process Areas relating to software process improvement were moved to a separate section in order to enable small software firms to implement a continuous software development process improvement program inside their firms.

The PAL-SPI model uses a point scale which was used to design the SPISO model in order to determine the maturity of the software firms.

Using the point scale in PAL-SPI, the software development firm will be able to determine where it is located on the scale and hence determine its maturity level. Each maturity level is worth to a number of predefined points that needs to be gathered by the software firm by implementing the Process Areas and their associated activities.

7.3. The current Situation of Small Software Development Firms in Palestine

The PAL-SPI model can be used to identify the current situation of small Palestinian software development firms. This can be done using the aggregated results achieved for each Process Area in the survey questionnaire.

Table 7-1 presents the achieved results for small Palestinian software development firms that have participated in the survey questionnaire which was conducted in this study. Each Process Area that got an average result of 3.5 or above has been considered as an implemented category and will get the total number of points that is valued for it within PAL-SPI model.

Table (7-1): The Current Situation of Small Palestinian Software Development Firms

Group	Process Area	P.A. Value	P.A Result
Group1	Requirements Management	16	16
	Requirements Development	16	16
	Project Planning	16	16
	Project Monitoring and Control	16	16
Group2	Organizational Training	4	0
	Validation	4	4
	Product Integration	4	4
	Technical Solution	4	4
Group3	Process And Product Quality Assurance	1	1
	Risk Management	1	0
	Configuration Management	1	0
	Verification	1	0
	Total	**84**	**77**

None of the process improvement categories which are included in Section 2 of PAL-SPI model is implemented inside these firms.

The total earned points for the implemented categories are 77 point. This places the average software development firms in Palestine at level 2 of Pal-SPI model. This means that these organizations still need to improve their software development processes by implementing other Process Areas which are included in PAL-SPI model. Table 7-2 lists the Process Areas that needs to be addressed and implemented by small software firms in Palestine.

Table (7-2): The Process Areas that need to be addressed and implemented by small software firms in Palestine.

Process Area
Risk Management
Configuration Management
Verification
Organizational Training
Organizational Performance Management (OPM)
Organizational Process Focus (OPF)
Organizational Process Performance (OPP)
Measurement And Analysis (M&A)
Quantitative Project Management (QPM)

This result justifies the need for process improvement program inside small software firms in Palestine.

7.4.Research Objectives

Based on the information presented and concluded in previous section, we can conclude that the thesis has achieved its objectives which were to:

1. Clarify the current situation of software process improvement inside small Palestinian software development firms.

2. Enable small Palestinian software development firms to assess their current software process/s and find areas to improve.

3. Propose a process improvement model that is dedicated for the use inside small Palestinian software firms.

7.5. Research Questions

In this section, the research questions will be discussed. The research sought answers for the following questions:

- **Are there Process Areas that can be excluded when pursing process improvement in small software firms?**

Although all of the key Process Areas which were included in the survey were considered important by all of the survey participants, the researcher has decided to exclude 5 out of the total 22 Process Areas. The reason why has this decision been made was that the five excluded process areas were not found in the majority of the compared models in chapter three and the researcher wanted to produce a simplified model that is easy to understand and easy to apply be small software firms in an economic way.

- **What Process Areas of SPI are most applied in small Palestinian software development firms?**

The results of this research indicated that the following Process Areas are the most implemented inside small software firms in Palestine:

- Validation
- Requirements Management
- Requirements Development

- Project Planning
- Product Integration
- Project Monitoring and Control
- Causal Analysis And Resolution - Defect Prevention
- Process And Product Quality Assurance
- Technical Solution

- **What Process Areas of SPI are considered most important by small Palestinian firms?**

The results of this research indicated that the following Process Areas are considered the most important for small software firms in Palestine:

- Requirements Management
- Requirements Development
- Project Planning
- Project Monitoring and Control
- Organizational Training

7.6. Contribution to Knowledge and Practice

This research made several contributions to the domain. The contribution can be summarized as bellow:

1. Clarifying the current situation of software development process in small software firms in Palestine.

2. Developing a simplified framework for small software development firms in Palestine. (See Appendix B)

7.7. Future Work and Recommendations

After the effort that has been done in order to develop the targeted framework, and after presenting the above conclusions, some notes and recommendations can be summarized and suggested for future work. The following points summarize these suggestions:

7.7.1. Implementation of PAL-SPI model:

The primary objective for this thesis was to develop a simplified software process improvement model for small software firms in Palestine. The first recommendation for this work is to apply PAL-SPI model inside number of small software firms and then conduct a case study on each of them. This will help in refining and improving the model on the basis of feedback and lessons learned.

7.7.2. Checking Cultural Impact on models used in small firms:

This research encourages future work toward applying PAL-SPI model in other countries such as Syria and Saudi Arabia in order to check the cultural impact on software process model used.

7.7.3. Building other models using other methodologies:

This research encourages building other models that are tailored for small software development firms in Palestinian market using other methodologies such as SPICE, ISO 9001:2000, Trillium, BOOTSTRAP and Six Sigma. Then, testing these models on Palestinian software development firms and adopting the best of them as a standard for small software development companies in Palestine.

7.7.4. CMMI and Six Sigma

The researcher of this thesis encourages investigating the possible synergy between CMMI and Six Sigma as a two improvement-oriented initiatives inside small Palestinian software development firms. The scope of the research should seek answers regarding the following questions [Nayab 2011, Jeannine 2005]:

- The possible synergy for implementing these two approaches in an integrated fashion or as layered efforts.
- Selecting the best implementation approach based on small Palestinian software development organizations' circumstances.
- How to apply both of these two improvement initiatives within small Palestinian software development firms so as to save efforts, be more effective and get benefit from this possible synergy.

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Appendixes

Appendix A – Survey Questionnaire

Categories/Questions	Activity is integrated						Activity is Important	
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		Yes	No
	1	2	3	4	5		1	2
1. Requirements Management								
Question 1 - Manage Requirements - Requirements are managed and inconsistencies with project plans and work products are identified.								
2. Project Planning								
Question 2 - Establish Estimates - Estimates of project planning parameters are established and maintained.								
Question 3 - Develop a Project Plan - A project plan is established and maintained as the basis for managing the project.								
Question 4 - Obtain Commitment to the Plan - Commitments to the project plan are established and maintained.								
3. Supplier Agreement Management (The purpose of Supplier Agreement Management (SAM) is to manage the acquisition of products and services from suppliers)								
Question 5 - Establish Supplier Agreements - Agreements with the suppliers are established and maintained.								
Question 6 - Satisfy Supplier Agreements - Agreements with the suppliers are satisfied by both the project and the supplier.								

4. Measurement And Analysis								
Question 7 - Align Measurement and Analysis Activities - Measurement objectives and activities are aligned with identified information needs and objectives.								
Question 8 - Provide Measurement Results - Measurement results that address identified information needs and objectives are provided.								
5. Process And Product Quality Assurance								
Question 9 - Objectively Evaluate Processes and Work Products - Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated.								
Question 10 - Provide Objective Insight - Noncompliance issues are objectively tracked and communicated, and resolution is ensured.								
6. Configuration Management								
Question 11 - Establish Baselines - Baselines of identified work products are established.								
Question 12 - Track and Control Changes - Changes to the work products under configuration management are tracked and controlled.								
Question 13 - Establish Integrity -Integrity of baselines is established and maintained.								
7. Requirements Development								
Question 14 - Develop Customer Requirements - Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.								

Question 15 - Develop Product Requirements - Customer requirements are refined and elaborated to develop product and product-component requirements.								
Question 16 - Analyze and Validate Requirements - The requirements are analyzed and validated, and a definition of required functionality is developed.								
8. Technical Solution								
Question 17 - Select Product-Component Solutions - Product or product-component solutions are selected from alternative solutions.								
Question 18 - Develop the Design - Product or product-component designs are developed.								
Question 19 - Implement the Product Design - Product components, and associated support documentation, are implemented from their designs.								
9. Product Integration								
Question 20 - Prepare for Product Integration - Preparation for product integration is conducted.								
Question 21 - Ensure Interface Compatibility - The product-component interfaces, both internal and external, are compatible.								
Question 22 - Assemble Product Components and Deliver the Product - Verified product components are assembled and the integrated, verified, and validated product is delivered.								
10. Verification (The purpose of Verification (VER) is to ensure that selected work products meet their specified requirements)								

Question 23 - Prepare for Verification - Preparation for verification is conducted.								
Question 24 - Perform Peer Reviews - Peer reviews are performed on selected work products.								
Question 25 - Verify Selected Work Products - Selected work products are verified against their specified requirements.								
11. Validation (The purpose of Validation (VAL) is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment)								
Question 26 - Prepare for Validation - Preparation for validation is conducted.								
Question 27 - Validate Product or Product Components - The product or product components are validated to ensure that they are suitable for use in their intended operating environment.								
12. Organizational Process Focus								
Question 28 - Determine Process-Improvement Opportunities - Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.								
13. Organizational Process Definition								
Question 29 - Plan and Implement Process-Improvement Activities - Improvements are planned and implemented, organizational process assets are deployed, and process-related experiences are incorporated into the organizational process assets.								

Question 30 - Establish Organizational Process Assets - A set of organizational process assets is established and maintained.								
14. Organizational Training								
Question 31 - Establish an Organizational Training Capability - A training capability that supports the organization's management and technical roles is established and maintained.								
Question 32 - Provide Necessary Training - Training necessary for individuals to perform their roles effectively is provided.								
15. Integrated Project Management								
Question 33 - Use the Project's Defined Process - The project is conducted using a defined process that is tailored from the organization's set of standard processes.								
Question 34 - Coordinate and Collaborate with Relevant Stakeholders - Coordination and collaboration of the project with relevant stakeholders is conducted.								
16. Risk Management								
Question 35 - Prepare for Risk Management - Preparation for risk management is conducted.								
Question 36 - Identify and Analyze Risks - Risks are identified and analyzed to determine their relative importance.								
Question 37 - Mitigate Risks - Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.								

17. Decision Analysis And Resolution								
Question 38 - Evaluate Alternatives - Decisions are based on an evaluation of alternatives using established criteria.								
18. Organizational Process Performance								
Question 39 - Establish Performance Baselines and Models - Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.								
19. Quantitative Project Management								
Question 40 - Quantitatively Manage the Project - The project is quantitatively managed using quality and process-performance objectives.								
Question 41 - Statistically Manage Subprocess Performance - The performance of selected subprocesses within the project's defined process is statistically managed.								
20. Causal Analysis And Resolution								
Question 42 - Determine Causes of Defects - Root causes of defects and other problems are systematically determined.								
Question 43 - Address Causes of Defects - Root causes of defects and other problems are systematically addressed to prevent their future occurrence.								
21. Organizational Performance Management								
Question 44 - Aggregated project data is iteratively analyzed								
Question 45 - Gaps in performance against the business objectives are identified								

Question 46 - Improvements to close the gaps are selected and deployed								
22. Project Monitoring and Control								
Question 47 - Appropriate corrective actions can be taken when the project's performance deviates significantly from the plan								

Appendix B - PAL - SPI-MODEL

In this appendix the Pal-SPI Model will be presented with all its section, categories, and activities. Figure 1 shows the general architecture of the model and Figure 2 shows the architecture of the model with its main Sections, Groups and Categories.

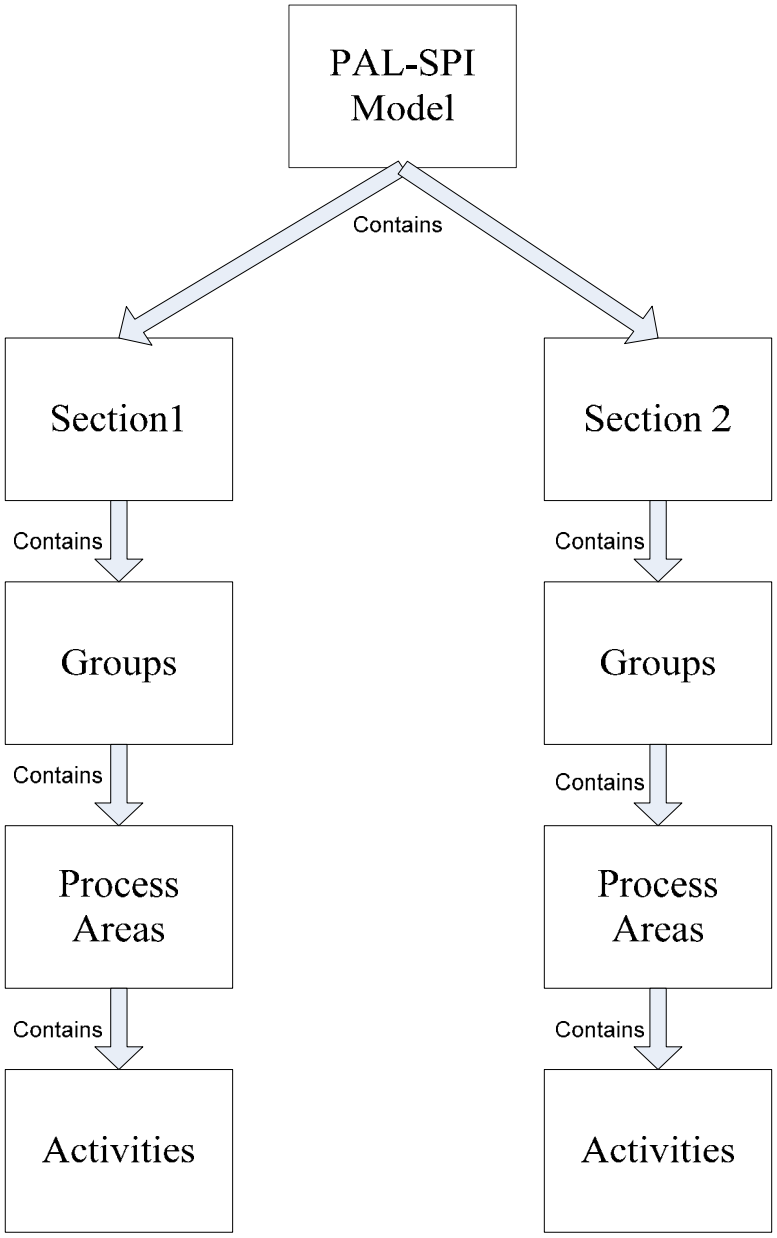

Figure 1 shows the architecture of the model.

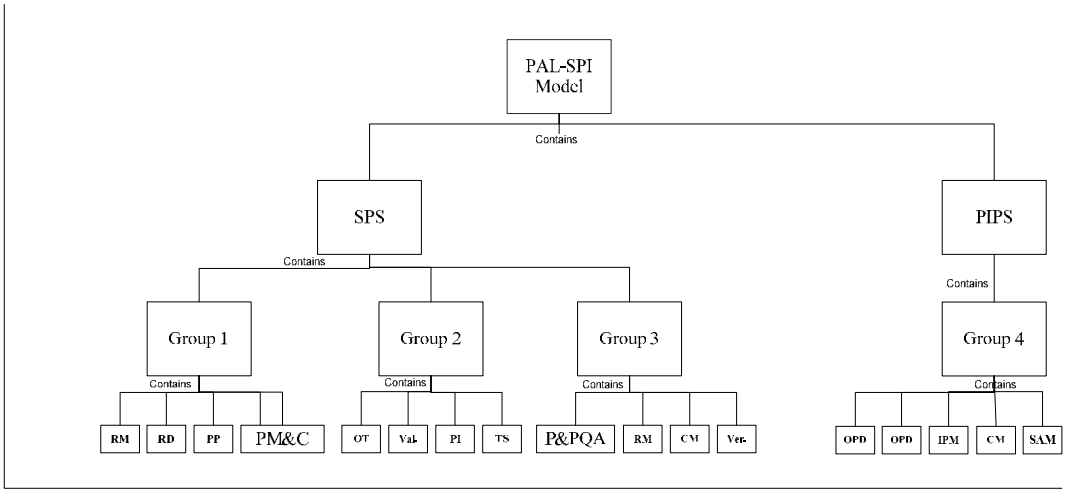

Figure 2 shows the architecture of the model with its main Sections, Groups and Categories

PAL – SPI –Model Components

1 Section 1

1.1 Group 1

1.1.1 Requirements Management

1.1.1.1 Goal 1 [Manage Requirements - Requirements are managed and inconsistencies with project plans and work products are identified.]

1.1.1.1.1 Activity 1 - Obtain an Understanding of Requirements

1.1.1.1.2 Activity 2 - Obtain Commitment to Requirements

1.1.1.1.3 Activity 3 - Manage Requirements Changes

1.1.1.1.4 Activity 4 - Maintain Bidirectional Traceability of Requirements

1.1.1.1.5 Activity 5 - Inconsistencies between Project Work and Requirements

1.1.2 Requirements Development

1.1.2.1 Goal 1 [Develop Customer Requirements - Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements]

1.1.2.1.1 Activity 1- Elicit Needs

1.1.2.1.2 Activity 2 - Develop the Customer Requirements

1.1.2.2 Goal 2 [Develop Product Requirements - Customer requirements are refined and elaborated to develop product and product-component requirements]

1.1.2.2.1 Activity1-Establish Product and Product-Component Requirements

1.1.2.2.2 Activity2 - Allocate Product-Component Requirements

1.1.2.2.3 Activity3 - Identify Interface Requirements

1.1.2.3 Goal 3 [Analyze and Validate Requirements - The requirements are analyzed and validated, and a definition of required functionality is developed]

1.1.2.3.1 Activity 1 - Establish Operational Concepts and Scenarios

1.1.2.3.2 Activity 2 - Establish a Definition of Required Functionality

1.1.2.3.3 Activity 3 - Analyze Requirements

1.1.2.3.4 Activity 4 - Analyze Requirements to Achieve Balance

1.1.2.3.5 Activity 5 – Validate Requirements with Comprehensive Methods

1.1.3 Project Planning

1.1.3.1 Goal 1[Establish Estimates - Estimates of project planning parameters are established and maintained]

1.1.3.1.1 Activity 1: Estimate the Scope of the Project

1.1.3.1.2 Activity 2: Establish Estimates of Work Product and Task Attributes

1.1.3.1.3 Activity 3: Define Project Life Cycle

1.1.3.1.4 Activity 4: Determine Estimates of Effort and Cost

1.1.3.2 Goal 2 [Develop a Project Plan - A project plan is established and maintained as the basis for managing the project.]

1.1.3.2.1 Activity 1: Establish the Budget and Schedule

1.1.3.2.2 Activity 2: Identify Project Risks

1.1.3.2.3 Activity 3: Plan for Data Management

1.1.3.2.4 Activity 4: Plan for Project Resources

1.1.3.2.5 Activity 5: Plan for needed Knowledge and Skills

1.1.3.2.6 Activity 6: Plan Stakeholder involvement

1.1.3.2.7 Activity 7: Establish the project Plan

1.1.3.3 Goal 3 [Obtain Commitment to the Plan – Commitments to the project plan are established and maintained.]

1.1.3.3.1 Activity 1: Review Plans that affect the project

1.1.3.3.2 Activity 2: Reconcile Work and Resource Levels

1.1.3.3.3 Activity 3: Obtain Plan Commitment

1.1.4 Project Monitoring and Control

1.1.4.1 Goal 1 [understand of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan]

1.1.4.1.1 Activity 1: Monitor the Project against the Plan

1.1.4.1.2 Activity2: Manage Corrective Action to Closure

1.2 Group 2

1.2.1 Organizational Training

1.2.1.1 Goal 1 [Establish an Organizational Training Capability - A training capability that supports the organization's management and technical roles is established and maintained]

1.2.1.1.1 Activity 1: Establish the Strategic Training Needs

1.2.1.1.2 Activity 2: Determine Which Training Needs Are the Responsibility of the organization

1.2.1.1.3 Activity 3: Establish an Organizational Training Tactical Plan

1.2.1.1.4 Activity 4: Establish Training Capability

1.2.1.2 Goal 2 [Provide Necessary Training - Training necessary for individuals to perform their roles effectively is provided.]

1.2.1.2.1 Activity 1: Deliver Training

1.2.1.2.2 Activity 2: Establish Training records

1.2.1.2.3 Activity 3: Assess training effectiveness

1.2.2 Validation

1.2.2.1 Goal 1 [Prepare for Validation - Preparation for validation is conducted.]

1.2.2.1.1 Activity 1 - Select Products for Validation

1.2.2.1.2 Activity 2 - Establish the Validation Environment

1.2.2.1.3 Activity 3 - Establish Validation Procedures and Criteria

1.2.2.2 Goal 2 [Validate Product or Product Components - The product or product components are validated to ensure that they are suitable for use in their intended operating environment]

1.2.2.2.1 Activity 1 - Perform Validation

1.2.2.2.2 Activity 2 - Analyze Validation Results

1.2.3 Product Integration

1.2.3.1 Goal 1 [Prepare for Product Integration - Preparation for product integration is conducted]

1.2.3.1.1 Determine Integration Sequence

1.2.3.1.2 Establish the Product Integration Environment

1.2.3.1.3 Establish Product Integration Procedures and Criteria

1.2.3.2 Goal 2 [Ensure Interface Compatibility - The product-component interfaces, both internal and external, are compatible]

1.2.3.2.1 Activity 1: Review Interface Descriptions for completeness.

1.2.3.2.2 Activity 2: Manage Interfaces

1.2.3.3 Goal 3 [Assemble Product Components and Deliver the product- verified product components are assembled and the integrated, verified, and validated product is delivered]

1.2.3.3.1 Activity 1: Confirm Readiness of Product Components for Integration

1.2.3.3.2 Activity 2: Assemble Product Components

1.2.3.3.3 Activity 3: Evaluate Assembled Product Components

1.2.3.3.4 Activity 4: Package and Deliver the Product or Product Component

1.2.4 Technical Solution

1.2.4.1 Goal 1[Select Product-Component Solutions - Product or product-component solutions are selected from alternative solutions]:

1.2.4.1.1 Activity 1: Develop Detailed Alternative Solutions and Selection Criteria

1.2.4.1.2 Activity 2: Evolve Operational Concepts and Scenarios

1.2.4.1.3 Activity 3: Select Product-Component Solutions

1.2.4.2 Goal 2 [Develop the Design - Product or product-component designs are developed]:

1.2.4.2.1 Activity 1: Design the Product or Product Component

1.2.4.2.2 Activity 2: Establish a Technical Data Package

1.2.4.2.3 Activity 3: Design Interfaces Using Criteria

1.2.4.2.4 Activity 4: Perform Make, Buy, or Reuse Analyses

1.2.4.3 Goal 3 [Implement the Product Design - Product components, and associated support documentation, are implemented from their designs]:

1.2.4.3.1 Activity 1: Implement the Design

1.2.4.3.2 Activity 2: Develop Product Support Documentation

1.3 Group 3

1.3.1 Process and Product Quality Assurance

1.3.1.1 Goal 1 [Objectively Evaluate Processes and Work Products - Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated]

1.3.1.1.1 Activity 1 - Objectively Evaluate Process

1.3.1.1.2 Activity 2 - Objectively Evaluate Work Products and Services

1.3.1.2 Goal 2 [Provide Objective Insight - Noncompliance issues are objectively tracked and communicated, and resolution is ensured]

1.3.1.2.1 Activity 1 – Communicate and Ensure resolution of noncompliance issues

1.3.1.2.2 Activity 2 –Establish Records

1.3.2 Risk Management

1.3.2.1 Goal 1 [Prepare for Risk Management – Preparation for risk management is conducted]

1.3.2.1.1 Activity 1: Determine Risk Sources and Categories

1.3.2.1.2 Activity 2: Define Risk Parameters

1.3.3.3.2 Activity 2: Perform Configuration Audits

1.3.4 Verification

1.3.4.1 Goal 1 [Prepare for Verification- preparation for verification is conducted]

1.3.4.1.1 Activity 1: Select Work Products for Verification.

1.3.4.1.2 Activity 2: Establish The Verification Environment.

1.3.4.1.3 Activity 3: Establish Verification Procedures and criteria.

1.3.4.2 Goal 2 [Perform Peer Reviews - Peer reviews are performed on Selected work products]

1.3.4.2.1 Activity 1: Prepare for peer reviews.

1.3.4.2.2 Activity 2: Conduct Peer Reviews.

1.3.4.2.3 Activity 3: Analyze Peer review data.

1.3.4.3 Goal 3 [Verify Selected Work Products – Selected work productsare verified against their specified requirements.]

1.3.4.3.1 Activity 1: Perform Verification.

1.3.4.3.2 Activity 2: Analyze verification results and identify corrective actions.

2 Section 2

This part will list the activities in the second section of the model. The activities are categorized by the group and the Process Areas it belongs to.

2.1 Group 4

2.1.1 Organizational Performance Management

2.1.1.1 Goal 1 [Select Improvements - Process and technology improvements that contribute to meeting quality and process-performance objectives are selected]

2.1.1.1.1 Activity 1: Collect and Analyze Improvement Proposals

2.1.1.1.2 Activity 2: Identify and Analyze Innovations

2.1.1.1.3 Activity 3: Pilot Improvements

2.1.1.1.4 Activity 4: Select Improvements for Deployment

2.1.1.2 Goal 2 [Deploy Improvements - Measurable improvements to the organization's processes and technologies are continually and systematically deployed]

2.1.1.2.1 Activity 1: Plan the Deployment

2.1.1.2.2 Activity 2: Manage the Deployment

2.1.1.2.3 Activity 3: Measure Improvement Effects

2.1.2 Organizational Process Performance

2.1.2.1 Goal 1 [Establish Performance Baselines and Models - Baselines and models that characterize the expected process performance of the organization’s set of standard processes are established and maintained.]

2.1.2.1.1 Activity 1: Select Processes

2.1.2.1.2 Activity 2: Establish Process Performance Measures

2.1.2.1.3 Activity 3: Establish Quality and process performance objectives

2.1.2.1.4 Activity 4: Establish Process Performance Baselines

2.1.2.1.5 Activity 5: Establish Process Performance Models

2.1.3 Organizational Process Focus

2.1.3.1 Goal 1 [Determine Process-Improvement Opportunities - Strengths, weakness, and improvement opportunities for the organization's processes are identified periodically and as needed]

2.1.3.1.1 Activity 1: Establish Organizational Process Needs

2.1.3.1.2 Activity 2: Appraise the Organization’s Processes

2.1.3.1.3 Activity 3: Identify the Organization's Process Improvements

2.1.3.2 Goal 2 [Plan and Implement Process-Improvement Activities, Improvements are planned and implemented, organizational process assets are deployed, and process-related experience are incorporated into organizational process assets.]

2.1.3.2.1 Activity 1: Establish Process Action Plans

2.1.3.2.2 Activity 2: Implement Process Action plans

2.1.3.2.3 Activity 3: Deploy Organizational Process Assets

2.1.3.2.4 Activity 4: Incorporate Process-Related Experiences into the organizational process assets.

2.1.4 Quantitative Project Management

2.1.4.1 Goal 1 [Quantitatively Manage the Project - The project is quantitatively managed using quality and process performance objectives]

2.1.4.1.1 Activity 1: Establish the Project’s Objectives

2.1.4.1.2 Activity 2: Compose the Defend process

2.1.4.1.3 Activity 3: Select the Sub processes that Will Be Statistically Managed

2.1.4.1.4 Activity 4: Manage Project Performance

2.1.4.2 Goal 2 [Statistically Manage Sub-process Performance - The performance of selected sub-processes within the project's defined process is statistically managed]

2.1.4.2.1 Activity 1: Select Measures and Analytic Techniques

2.1.4.2.2 Activity 2: Apply Statistical Methods to Understand Variation

2.1.4.2.3 Activity 3: Monitor Performance of the Selected Sub-processes

2.1.4.2.4 Activity 4: Record Statistical Management Data

2.1.5 Measurements and Analysis

2.1.5.1 Goal 1 [Align Measurement and Analysis Activities - Measurement objectives and activities are aligned with identified information needs and objectives]

2.1.5.1.1 Activity 1: Establish Measurement Objectives

2.1.5.1.2 Activity 2: Specify Measures

2.1.5.1.3 Activity 3: Specify Data Collection and Storage Procedures

2.1.5.1.4 Activity 4: Specify Analysis Procedures

2.1.5.2 Goal 2 [Provide Measurement Results - Measurement results that address identified information needs and objectives are provided]

2.1.5.2.1 Activity 1: Collect Measurement Data

2.1.5.2.2 Activity 2: Analyze Measurement Data

2.1.5.2.3 Activity 3: Store Data and Results

جامعة النجاح الوطنية
كلية الدراسات العليا

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قدمت هذه الأطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في الإدارة الهندسية بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين
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د. بكر عبد الحق

الملخص

يهدف هذا البحث إلى تطوير نموذج مصغر لعملية تطوير البرمجيات في الشركات الفلسطينية الصغيرة بحيث يساعد هذه الشركات على فهم ومعرفة العمليات المتبعة لتطوير البرمجيات داخل شركاتهم وتحديد الجوانب اللازمة لتحسين هذه العمليات.

حاول العديد من الجامعات ومراكز الابحاث واتحادات تطوير البرمجيات في العديد من دول العالم من تطوير نماذج مخصصة للاستخدام في الشركات الصغيرة. لكن معظم هذه النماذج كانت معقدة ولا يسهل تطبيقها داخل هذه الشركات. بالاضافة إلى انه لم يمثل اي من هذه النماذج نموذجا موحدا يمكن تطبيقه في جميع الشركات الصغيرة حول العالم حيث ان هذه النماذج طورت بناءا على معلومات جمعت من شركات تطوير البرمجيات في البلد الذي طوَرت من أجله.

بناء على ذلك ومع الأخذ بعين الاعتبار ثقافة البلد والشركات عند تطبيق نموذج أجنبي لغرض تحسين عملية تطوير البرمجيات، قام الباحث بتطوير نموذج مصغر يسهل فهمه وتطبيقه داخل الشركات الفلسطينية الصغيرة والذي سمَي (PAL-SPI). يمثل (PAL-SPI) أداة يسهل فهمها وتطبيقها لتساعد هذه الشركات على تحسين عملية تطوير البرمجيات وتطوير قدرتها على انتاج برمجيات أكثر جودة وبطريقة أكثر كفاءة.

استخدم الباحث المنهج الكمي لإتمام عمله البحثي، حيث قام باستخدام طريقة الاستبانة الالكترونية التي تم تصميمها بالاعتماد على نموذج تحديد القدرة التكاملية المصمم من خلال معهد هندسة البرمجيات في جامعة كارنيجي ميلون الأميركية (CMMI V1.3) بالاضافة إلى

عدد من النماذج التي صممت لنفس الهدف في عدد من دول العالم مثل (SPISO) الذي صـــمم في السويد. وقد قام الباحث بتوزيع الاستبانة من خلال البريد الالكتروني لكل من أفــراد العينـــة البحثية والتي هي عبارة عن 40 شركة فلسطينية صغيرة تعمل في مجال تطـــوير البرمجيـــات، وقد أعيد 30 استبانة مكتملة خلال خمسة أسابيع، حيث بلغت نسبة الاستجابة 75% من العينـــة المستهدفة.