THE REPUBLIC OF TURKEY
BAHCESEHIR UNIVERSITY

AGILE SOFTWARE DEVELOPMENT PROJECT EVALUATION BY USING THE PARTIAL LEAST SQUARES - STRUCTURAL EQUATION MODELING (PLS-SEM) APPROACH IN THE VIEW OF CRITICAL SUCCESS INDICATORS' SUCCESS RESEARCH

Master's Thesis

ŞENAY DEMİREL

ISTANBUL, 2016

THE REPUBLIC OF TURKEY
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GRADUATE SCHOOL OF NATURAL AND
APPLIED SCIENCES
COMPUTER ENGINEERING (ENGLISH - THESIS)

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ABSTRACT

AGILE SOFTWARE DEVELOPMENT PROJECT EVALUATION BY USING THE PARTIAL LEAST SQUARES - STRUCTURAL EQUATION MODELING (PLS-SEM) APPROACH IN THE VIEW OF CRITICAL SUCCESS INDICATORS' SUCCESS RESEARCH

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In this study, who has a rising trend in recent years, Agile Software Development Process has been analyzed by means of Success Criterias and the effects of those criterias have been determined by using Partial Least Squares - Structural Equation Modeling (PLS-SEM) methodology.

Success Criterias for Agile Software Development Process (ASDP) are grouped into five main categories and considered as the "main criterias". Each Main criteria composed of few "sub-criterias" and each sub-criterias also composed of more than one "detail criterias" which are all evaluated separately.

To collect data on each of the detail criterias of Agile Software Development Process the survey method has been used. The effect of each detail criterias on the success of a Project which is developed by applying Agile Software Development Process is measured with the answers gathered from this survey. Participants of the survey have different roles and levels of experience both on software development generally and specifically on agile software development and process.

In Analysis Phase, all answers were mapped to the detailed criterias and applied into a model which is developed by using PLS - SEM method. With the results gathered by running this model, the effects of each sub criterias that are mapped to one of the main criterias of ASDP have been determined and evaluated.

Keywords: Critical Success Factors, Success Criterias, Agile Software Development Process, Partial Least Squares - Structural Equation Modeling (PLS-SEM)

ÖZET

KISMİ EN KÜÇÜK KARELER – YAPISAL EŞİTLİK MODELLEMESİ (PLS-SEM) KULLANARAK ÇEVİK YAZILIM GELİŞTİRME PROJELERİNDE KRİTİK BAŞARI FAKTÖRLERİNİN BAŞARI ANALİZİ

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Bilgisayar Mühendisliği

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Bu tez çalışmasında, son yıllarda yükselen bir eğilim olarak talep gören Çevik Yazılım Geliştirme Sürecinin başarı kriterleri belirlenmiş ve bu kriterlerin etkileri Kısmi En Küçük Kareler – Yapısal Eşitlik Modellemesi (PLS-SEM) kullanılarak analiz edilmiştir.

Çevik Yazılım Geliştirme Süreçlerinin başarı faktörlerini açıklamak üzere belirlenmiş olan kriterler beş temel başlıkta toplanmış ve bunlar ana kriterler olarak değerlendirilmiştir. Bu ana kriterleri oluşturan alt kriterler belirlenmiş ve bu alt kriterler ayrıntılandırılarak detay kriterlere bölünmüş ve herbiri ayrı ayrı değerlendirilmiştir.

Bu detay kriterlerin Çevik Yazılım Geliştirme Süreçleri üzerindeki etkisi ve uygulanan projenin başarısına katkıları hakkında veri toplamak için anket yöntemi kullanılmıştır. Yazılım geliştirme ve Çevik Yazılım Geliştirme Süreci konularında bilgili, farklı rollerde ve tecrübe seviyelerinde olan mühendislerin fikirleri alınmıştır.

Analiz aşamasında, anket sorularına verilmiş olan cevaplar detay kriterlerle eşleştirilmiş ve Kısmi En Küçük Kareler – Yapısal Eşitlik Modellemesi yöntemi ile uygun bir modele uygulanmıştır. Bu model üzerinden alınan sonuçlar ile Çevik Yazılım Geliştirme Süreçlerinde belirlenmiş olan detay kriterlerin etkileri saptanmıştır.

Anahtar Kelimeler: Çevik Yazılım Geliştirme Süreci, Kritik Başarı Faktörleri, Başarı Kriterleri, Kısmi En Küçük Kareler – Yapısal Eşitlik Modellemesi

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ABBREVIATIONS/SYMBOLS

ASD	:	Agile software development
ASDP	:	Agile software development process
CSF	:	Critical success factors
GoF	:	Goodness of fit
LV	:	Latent variable
MV	:	Manifest variable
MIMIC	:	Multiple effect indicators for multiple causes
PLS	:	Partial least squares
PLS-SEM	:	Partial least squares - structural equation modeling
PLS-PM	:	Partial least squares - path modeling
MV_i, MV_j	:	Value of manifest variables (MV)
R^2	:	The coefficient of determination (R-square)

1. INTRODUCTION

Software is a “must have” necessity for many of the industries to handle the needs of the business and has been applied by organizations with following many different software disciplines. However investigations show it is still not well known or well defined the formula that results with success at the end of the software development projects, especially in agile projects.

The CHAOS Reports are the reports used to produce a snapshot for the industry of software development and have been published every year since 1994. Standish Group makes the study, releases the reports yearly and latest version has been provided for 2015 recently. Report includes various projects from different countries, with different types of projects like enhancements versus massive system designs or engineering activities which ended up including 50,000 projects in the analysis. Table 1.1 summarizes the results of the last five years defining the project success by using three factors (on time, on budget with quality) depicted from CHAOS manifesto (2015).

Table 1.1: Resolution for all projects

	2011	2012	2013	2014	2015
SUCCESFUL	29%	27%	31%	28%	29%
CHALLENGED	49%	56%	50%	55%	52%
FAILED	22%	17%	19%	17%	19%

Source: The CHAOS report, 2015, Standish Group

As it can be seen above, around 70 percent of the projects are still challenged or failed among the projects developed during last five years. Based on the size and impact on the industry, there has been many researches to identify the factors and focus to improve the success ratio in the software projects. Among many other software disciplines, Agile Methodology is one the most trending ones in this area.

Agility means the power of moving quickly and easily. Larman (2004) states that Agile Software Development Method is differentiated from traditional, plan-based approaches (such as Waterfall or sequential methodologies) in software engineering. It aims fast, light, effective and qualified development life cycle that supports customer`s involvement as much as possible with simple phases and quick turn arounds. In software development, applying agile methodologies means using the power of flexibility to move quickly and adaptively for applying changes over time. The main power of agile software development method is to provide a solution in increments, which starts with deployable units and developed over time into products with fully functional, scalable units. This is the cause why agile methodology is defined as an iterative method to make software development in shorter times with some lightweight deliverables and cycles.

Agile development methods started to rise at the end of 1990s, provided alternate solutions to the problems of waterfall and now is mostly used by different sectors and organizations among the other software development methodologies. Highsmith (2010) described agile methods, with the approaches of continuous delivery, integrated automation and testing, collaboration, adaptive coding, cooperation between multi functional teams, interchangeable planning and easy adaptation of tomorrow needs. Agile Alliance Group published Agile Software Development Manifesto (2001) to highlight:

"We are uncovering better ways of developing software by doing it and helping others do it. We value:

Individuals and interactions over processes and tools.
Working software over comprehensive documentation.
Customer collaboration over contract negotiation.
Responding to change over following a plan.
That is, while there is value in the items on the right,
We value the items on the left more."

Agile methods are based on the fundamental principles that are stated in the "Manifesto for Agile Software Development" (2001):

1. *Customer satisfaction by early and continuous delivery of valuable software*
2. *Welcome changing requirements, even in late development*
3. *Working software is delivered frequently (weeks rather than months)*
4. *Close, daily cooperation between business people and developers*
5. *Projects are built around motivated individuals, who should be trusted*

6. *Face-to-face conversation is the best form of communication (co-location)*
7. *Working software is the principal measure of progress*
8. *Sustainable development, able to maintain a constant pace*
9. *Continuous attention to technical excellence and good design*
10. *Simplicity—the art of maximizing the amount of work not done—is essential*
11. *Self-organizing teams*
12. *Regular adaptation to changing circumstance*

Ambler (2010) lists most common methods of Agile Software Development Process as shown in Table 1.2.

Table 1.2: Agile methodologies

<table>
<tr><th>Agile method</th><th colspan="2"></th></tr>
<tr><td rowspan="3">Extreme Programming</td><td colspan="2">Description
Built on the best practive approach. Fundamental practices are: gamification in the planning, small content in one release, simplest architecture and design, code pairing, cooperative ownership, continuous integration and testing, customer visit on-site, and 40 hour per week. XP2 also adds some enhancements such as colocation of the whole team, incremental development and shorter cycles.</td></tr>
<tr><td>Phases</td><td>Roles and Responsibilities</td></tr>
<tr><td>Exploration phase, Planning phase, Iterations to release phase, Productionizing phase</td><td>Programmer, Customer, Tester, Tracker, Coach, Consultant, Manager</td></tr>
<tr><td rowspan="3">Scrum</td><td colspan="2">Description
Developed is performed by scrum teams which are self organizing, initiative teams using the delivery mechanism of sprints. Each sprint starts with estimations, content plannnig, delivery and ends with lessons learned sessions. Backlogs adresses the requirements with design estimations provided with story points and prioritized by the product line managers or owners. Daily short stand up meetings keeps the team close , fast and effective.</td></tr>
<tr><td>Phases</td><td>Roles and Responsibilities</td></tr>
<tr><td>Pre-game phase, development phase, post-game phase,</td><td>Scrum master, Product owner, Scrum team, Customer, Manager,</td></tr>
<tr><td rowspan="2">Crystal Family of Methodologies</td><td colspan="2">Description
Color coding is used to define the emergency and sizing like red, blue or orange. Crystal Clear method, are applied in the small teams and teams that are developing non life critical projects. As like some other agile methodologies, focuses on the delivery cycle and methodology, communication, environment and team expertise.</td></tr>
<tr><td>Phases</td><td>Roles and Responsibilities</td></tr>
</table>

	Staging phase, revision and review phase, Iterator phase, demonstration to User phase	Sponsor, Senior Designer-programmer, designer-programmer, User
Feature Driven Development	***Description*** Is a combination of agile and model based development that builts on iterative design. In each iteration, design and then development phases are covered. Preferred in critical system development.	
	Phases	***Roles and Responsibilities***
	Develop and Overall model phase, Preparing features list phase, Planning phase, Design and Build phase,	Project manager, Chief architect, Development manager, Chief programmer, Class owner, Domain expert, Build engineer, Language guru, Toolsmith, System admin, Tester, Deployer, Technical writer, Release manager
The Rational Unified Process	***Description*** RUP is used mostly in object oriented development and uses UML modeling and focuses on building the framework for a system.	
	Phases	***Roles and Responsibilities***
	Inception phase, Elaboration phase, Construction Phase, Transition Phase	Business-Process Analyst, Business Designer, Business-Model Reviewer, Course Developer, Toolsmith,
Dynamic systems Development Method	***Description*** Projects are divided into 3 main phases in DSDM: project, pre and post project phases. Customer involvement are empowered and focused on building the future needs not just the current ones.	
	Phases	***Roles and Responsibilities***
	Feasibility, Business study phase, Model iteration phase, Design and build phase, implementation phase	Developer, Senior Developer, Technical coordinator, Ambassador user, Adviser user, Executive sponsor
Adaptive Software Development	***Description*** It enhances the waterfall methodology by adding some repetative actions to improve the process with repeating some cycles. This cycles introduces continuous learning and faster adaptation capabilities to the project.	
	Phases	***Roles and Responsibilities***
	Project initiation phase, Adaptive cycle planning phase, Concurrent component engineering phase, Quality Review phase, Release phase	Executive sponsor, Facilitator, Scriber, Project manager, Customer, Developer representatives
Open Source Software	***Description*** OSS development process tries to provide an innovative way to develop applications.	

Develop ment(OS S)	***Phases***	***Roles and Responsibilities***
	Problem discovery phase, Finding volunteers phase, Solution identification phase, Coding and testing phase, Code reviews, code delivery, documentation phase and Release management	Project Leaders, Volunteer developers, Volunter testers, Volunteer reporters, Posters

Source: Ambler, S., 2010, Scaling agile: an executive guide, IBM agility at scale

All of these methods provides more advantages than traditional methods as they are based on the manifesto principles such as; divide into smallest parts, plan properly, ensure customer involvement and deliver frequently. Chow and Cao (2008) also encourage open communication with daily “Stand ups”and focus on improving quality and project agility to improve the success of an agile projects. However, Agile practices is not well known for their efficiency or effectiveness and not well defined for their success and failure factors.

The Critical Success Factor (CSF) approach was developed by Rokhart in 1979 and later on became ineradicable. CSF is applied agile projects in order to define the performance criterias of an organization and identify the measurement methods. Critical Success Factors specifies the number of areas that will help to get competitive efficiency and effectiveness metrics for the team member, the team, or organization. Bullen and Rokhart (1981) summaries CSFs as exact answers of what parameters take away a project to success. CSFs in software projects are determined by using experience gained from previous projects. Mansor and others (2014) states Critical Success Factors in software development business to be related with software engineering as well as the combination of business and project management methodologies.

The CHAOS report 2015 has published a comparision between waterfall and agile software projects by means of project results. Table 1.3 shows that the results of the agile projects are appreciably better than the traditional approaches in all project sizes.

Table 1.3: Chaos resolution comparison

SIZE	METHOD		SUCCESSFUL	CHALLENGED	FAILED
All Size Projects	Agile		39%	52%	9%
	Waterfall		11%	60%	29%
Large Size Projects	Agile		18%	59%	23%
	Waterfall		3%	55%	42%
Medium Size Projects	Agile		27%	62%	11%
	Waterfall		7%	68%	25%
Small Size Projects	Agile		58%	38%	4%
	Waterfall		44%	45%	11%

Source: The CHAOS report, 2015, Standish Group

CSFs in agile processes will be the focus throughout the study with literature search, case studies and meta data and try to determine the success indicators in Agile. It will be beneficial to identify both success and failure factors of an agile projects and search the literature for both as failure factors will contribute to avoid the pitfalls that are certain or uncertain but critical. However this study will only be focused on identification of success for software development in projects that applies agile methodologies.

Paper structure is as follows: section 2 covers review of the literature list and proposed success factors framework, section 3 covers the data and methods by refering the survey that has been applied and PLS-SEM methodology that applied to the data set, section 4 covers findings including the initial and final PLS models, details of the model and the execution details, section 5 covers the discussion based on the modeling and gives the hypothesis that are supported by the results with literature comparison and finally section 6 covers the conclusion.

2. LITERATURE REVIEW

2.1 RESEARCH OVERVIEW

Research study aims to propose a multi-dimensional list of the CSFs used in the projects that follow ASD methodologies. This study started with the investigation of the literature that focuses on success factors of agile projects. Published papers, articles, online resources and reports related with agile development processes were researched as initial step. It has been observed that there are many different investigations that classifies the success factors. Based on that researches, they are classified into 5 categories: technical, organizational, process, people and project. For each category, main success factors are specified and analysed in the sub criterias of the main factors.
This method is applicable to have a multi-dimensional list of the success factors and apply to a model.

Then, a survey has been applied to gather data from software engineers and proposes a model to analyse the effectiveness of the criterias to the success of the agile projects. Proposed model can be used as an initial step to evaluate the current state of the factors and effect on the success.

2.2 LITERATURE LIST

Briefly, the thesis study reviews three main concepts; Agile method and Critical Success Factors (CSF), case studies and PLS-SEM modeling for evaluation method. So literature search has been focused on these three main concepts.

For literature based study on Agile method and CSFs ;

Doherty (2012) used the method of getting opinions from experienced program owners and project managers to determine the contribution, explore the management approach and evaluate the success factors to the projects success. 519 samples are collected from project owners that works on projects and have experience in leading on IT projects.

Two phased research approach are applied to the samples with employing a frequency analysis of the preferences applied to Q analysis method to combine and analysis the list of success factors. Then a detailed evaluation provided as an explanation for those critical success factors.

Nasir and Sahibuddin (2011) prepared a comparative study and used survey methodology in literature to determine the success factors that can potentially impact the project success. From the years 1990 to 2010, forty-three articles used and evaluated to propose the CSFs that affect the agile projects success. Prefered method for the study was content and frequency analysis methodologies. As a result of the analysis, twenty-six factors are determined as relative to project success. Among them top five success factors are suggested to be carefully focused by project managers or program owners as the frequency of occurences are more than 50 percent for each.

Wan and Wang (2010) focused to determine the key success factors among the CSFs for agile projects. They highlight that most critical factors are depended to the view of project manager who should analyze the return on investment and determine the most critical success factors depending on the project and implement them.

Charette (2005) determined the failure factors of an agile project which the opposite of those factors are evaluated as success factors.

Cockburn and Highsmith (2001) focused to the people factors specifically and evaluate the effects of people factor and if it can lead to the succcess in software development projects.

For case study and survey based studies, we explored many articles and found some country specific studies based on surveys or questionaries:

Abdulaziz and Mayhew (2013) performed a case study in Saudi Arabia to present the success factors that can effect the software projects. Study has performed a two phased method which combines quantitative and qualitative methods. In first phase, in order to collect the data and analyze, an interview has been performed. After the interview seventeen factors has been proposed as the success factors. In second phase, a questionnaire is used, to evaluate and validate the proposal as a quantitative method.

Wan and others (2013) focused on the manifesto and twelve agile principles, and performed a case study of J Group by applying an adaptive model. Study has determined the success factors as: 1) build the scrum as a self-managing group and a learning organization 2) professional release and development capability; 3) explicit project management. The study focused on the methodology of Scrum as J Group practices it.

Oferi (2013) performed another study in Ghana. It collected the data set by performing a survey on Ghanaian organizations. Knowledge creation theory has been used in the analysis of the data set and provided the critical success factors that contribute to the survey.

Nasir (2011) performed a Delphi study (five round) on Team Software Process (TSP) which aimed to determine the adherence of CSFs for agile software projects. Three experts participated to the study. Study findings supported the practices to adress best the fourteen success factors. The participants were agree on the outcomes of TSP which reproduce very good level for 4 of the success indicators, 'good' level for 6 of the success indicators, 'limited' level for only one of the indicators and none at the 'fair' degree.

Chow and Cao (2008) worked with 109 different agile projects among 25 different countries and gathered data by using the survey methodology. They applied different regression methods, both full and optimized models with the stepwise screening methods. Results were analyzed and supported only 10 among 48 hypothesis for the success factors.

For Partial Least Squares – Structural Equation Modeling below articles are studied and investigated:

Campanelli (2016) searched for the impacts of tailoring criteria that can be used on adoption of agile software development methodologies. His study first focused on the tailoring criterias available based on the literature search. Then, a model for agile practices adoption has been proposed with the base of the tailoring criteria. Survey has been used to collect the data among agile professionals and PLS-SEM used to evaluate the model proposed on the data set. Literature search showed that agile methods tailoring is an active research theme, the fundamental tailoring approaches are not specific to an agile method, the majority of the research used empirical research procedures, and that tailoring is mainly developed by using systematic method engineering approaches. Model has been validated and present the effect of the external and internal environment with previous knowledge and experience tailoring criteria on agile adoption. They also highlight organizations select agile practices according to their needs and tend to use custom methods or hybrid software practices. The proposed model can help the selection of agile methodologies based on the level of importance of each of the tailoring criteria has on the organization’s context for adoption.

Senapathi and Srinivasan (2014) published a study to validate and test a continuining agile usage or post-adoption based on a survey study. Survey data has been validated by using PLS-SEM models with variance and structural equations implemented in SmartPLS 2.0. Reliability has been checked with special focus by developing valid measures.

Findings support that coaching and relative advantage influences the selection for agile methodologies. They also supported the hypothesis that effectiveness in agile projects are measured with the extension of agile methodologies and intensity.

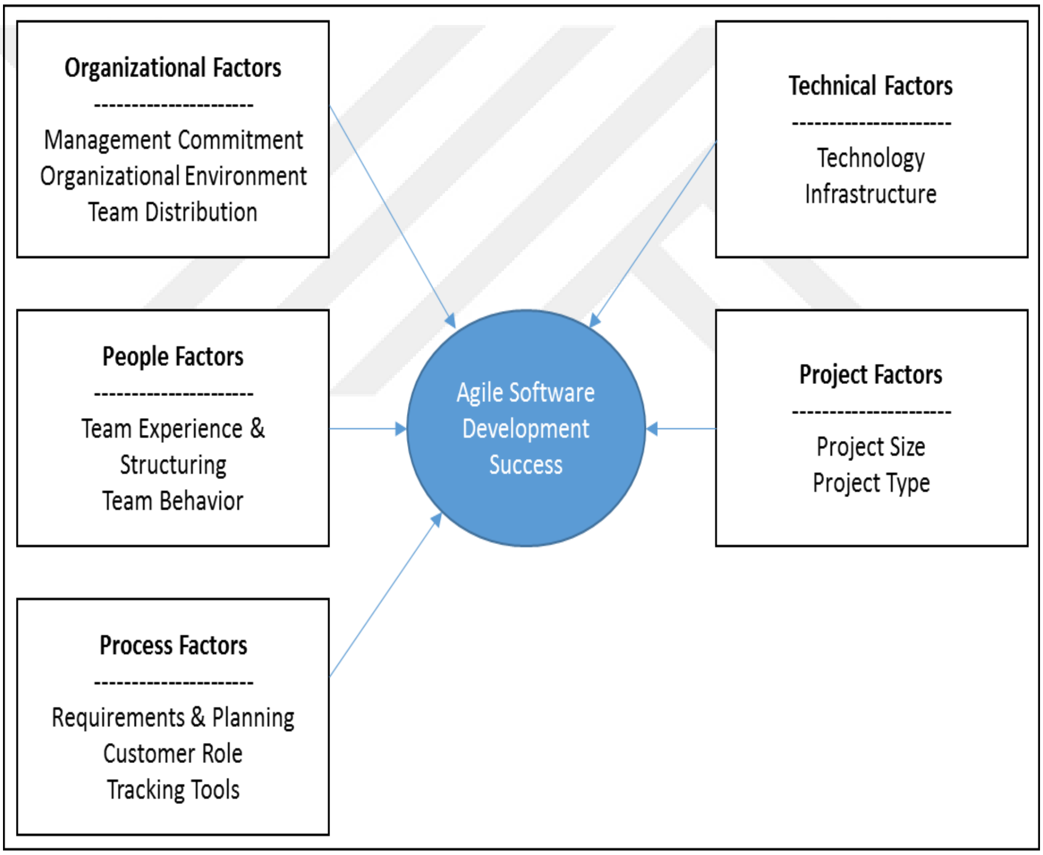
2.3 PROPOSED SUCCESS FACTORS FRAMEWORK

It is observed with the literature search that success criterias and researches are mainly based on either the case studies, personal observations of the experts from different agile practices or regression techniques applied to the data that gathered with different questionaries or surveys.

Based on the literature search, success factor framework depicted in Figure 2.1 has ben proposed. The proposed framework arranges success factors into 5 main categories; organizational, people, process, technical and project. Under each category there are success indicators and sub indicators (s).

It should be highlighted that the categorization and the framework proposals are from the researchers point of view based on the survey data.

Figure 2.1: Proposed agile success factors framework



2.3.1. Organizational Factors

Misra and others (2006) focused on the organizational factors and indicate that organizational impact to the success of a project are greater than the others. Organizational culture can influence many things from the top management to the engineer level. It includes getting support from executives for applying agile software development process, defines the process with phases and definition of done lists, determines the end user involvement and decides and operates the environment that the team will operate.

a) Management Commitment

Eworkshop held by Maryland Universty (2002) stated that agile teams should be encouraged to take their own decisions, take initiatives and succeed. Also, Cockburn and Highsmith (2001) states that critical decisions related with the project can be taken in a short timeframe with the collaboration of customer, business and design teams and advocated by agile development processes. Groans and Kruchten (2014) highlights the importance of management commitment to encoourage and support the team to decide and handle the circumctances of the results by taking self initiatives.

b) Organizational Environment (Corporate Culture)

Lindvall and others (2002) highlighted that agile should mainly supported by the organizational culture. If culture does not support or fit to agile, then organization can not be. Corporate culture should support the introduction and application of agile methodologies. For example organizations where are directed with burecracy may not fit for agile whereas dynamic organizations may. Because it requires extending the control of an individual or a team to the maximum possible limit, the characteristics and the nature is important. It will be more adaptoble to organizations where dynamic, and fast changing environments are already welcomed and applied. Organization culture should also support agilish behavioral expectations (i.e open cummunication) and have mechanisms to recognize them.

c) Team Distribution

According to Ken Schwaber (eWorkshop, 2002) colocation of the team is an important factor in an agile project to succeed. It is one of the factors that can help team to cooperate and influence people for success. Companies which are distributed, co-located in multiple areas and distributed internationaly in different countries will be effected the situations over that areas such as politicial or cultural differencies. Also number of the people within the team may affect the agility if the size is overwhelmed which will decrease the planning and control within the team.

2.3.2. People Factors

Kong (2007) states that the chance of the success in an agile project is often related to human factors and nature of behaviors. Different people factors are categorized as below which can effect the success of an agile project:

a) Team Experience (Competency) and Structuring

Lindvall and others (2002) defines competency as team having a real-world experience in particular technology that is in scope of the project, which shares same experience from their backgrounds plus have good relationship by means of communication and personal skills. In addition to experience, another important factor is the team structure which means the right team by the number of people and the composition of experts within the team. The distribution of the expertise levels within the team and numbers are considered as effective factor in agile but also team composition of estimation in between 25-33 percent (not firm) is also an important factor.

b) Team Behavior

Turner and Boehm (2003) states that team behavior and open and direct communication is an effective factor in ASD methodologies. As agile facilitates fast decisions, effective communication within the team as well as the customer and managers, team behavior is one of the effective CSFs. Daily sync up meetings in agile process provides quick and effective communication method which is face-to-face communication. It will also help the planning and control over the project delivery life cycle which will let people recognize the challenges with no time lost and let determine the corrective action fastly.

Team behavior such as responsibility, honesty, open communication, collaborative attitude, willing to learn and dedication is sometimes more important than the experience of the team members. People should be open and willing to learn continuously by asking the questions `what went well and not?`. Continued learning concept by having lessons learned or retrospective meetings are good methods supported by agile process and this effects the success of agile practices .

2.3.3. Process Factors

Process factors defines the phases of the project, specifies the milestones and determines the definition of done lists which are related to the functions or tasks of the project needs e.g code reviews, integration tests, defect management and the reporting. Starts with reqirement to planning phases with proper tools used in each phase of the project. Also enforcing customer being part of the process and involve directly to the project is considered as a an important factor.

a) Requirements and Planning

Changing requirements along the way are considered as normal in agile methodology, even in the late cycles in the development. Plan-driven methods have been successful when there is almost no change is welcomed after the initial plans are in place however agile methodologies include change management in all environments even in environments where requirements are challenged with unforeseeable changes. Project planning should also cover the changes and reflect them properly in project plans. The deliverables that process tracks will help the development cycle including requirement deliverables, documentation deliverables, verification efforts and delivery cycles of the development project.

b) Customer Role

There is a strong customer commitment and presence in agile projects which will let customer to provide comments, change the requirements or ask for additional requirements. Agile team should welcome those changes and get used to the change management. It includes customer involvement in early life cycle of project development, getting customer feedbacks as early as possible and adopt the project development according to customer requirements. In order to achieve this customers should also be highly motivated, active and feel responsible. Thus customer commitment is, an important success factor.

c) Tracking Tools

Following an agile-oriented process and tools have positive effect on delivering the project with success. While having regular delivery to the customer, definition of done lists are tracked and checked with the customer to ensure that the agile team is completed not only the coding itself but also the necessary documentation, validation and –if applicable- the automation. The deliverables that process tracks will help the development cycle including requirement deliverables, documentation deliverables, verification efforts and delivery cycles of the development project.

2.3.4. Technical Factors

Technical factors are factors that specifies the technical requirements of the project such as the implementation techniques or coding standarts and also specifies the hardware or technology that are used in the project. As all other factors, technical factors are one of the success factors that can lead the project to the success or not.

a) Technology

Even in the plan-driven development methods where there is some amount of design and refactoring efforts, which is simply re-implementing the code where functional behavior is kept but internal codes are rewritten, those changes are considered as expensive.

However, agile implementation techniques are evaluated to be more successful in environments which pursue well-defined coding standards up front and avoids inexpensive refactoring and provides right amount of documentation.

b) Infrastructure

Plan-driven methodology often provides the delivery at the completion of the implementation and testing in a longer period committed before, however, agile delivery is categorized as regular delivery in shorter periods in the forms of demos and prototypes which make possible to react customer's changing requests more fastly.

This enables to build the proper infrastructure to regular delivery in the prioritized list (most important features first) instead of all-in-a-one delivery in plan-driven methodology. Also needs the correct integration and automation systems built up with technical training provided to the team and environment defined.

2.3.5. Project Factors

a) Project Type

The type of the project (international, integration project etc.) might have a potential impact on project success factor. Projects that are done by multiple teams, located in different regions, especially in international projects, will be effected by the situations such as political, industrial or cultural by means of success.

b) Project Size

As stated in the CHAOS report 2015 the success ratio of small size projects are much higher than the large size projects. It can be observed from Table 1.3 that success ratio decreases from 58 to 18 percent from small to large size projects in Agile. Whereas in Waterfall, same ratio goes down from 44 to 3 percent. When project sizes are increasing, project content, shcedule, delivery, team and budget sizes are getting more and more complex and challenges project success.

3. DATA AND METHODS

As we observed in the literature search, we also refer to a case study to collect the data and build up the proper data set by using the survey method. We are also proposing a method to evaluate and investigate the data and determine the impacts of the success factors in agile developmet cycles.

This section covers the data collection method, data set and the methods that are used to evaluate and validate the data set.

3.1 DATA COLLECTION

In this study survey methodology is used to collect the data from project members such as engineers, scrum masters or project managers who are already working on agile projects or aware of agile methodologies and approaches. Survey posted via an online platforms available on the internet. (online survey)

The aim is to determine the impacts of key success factors with the effective usage of agile methodology. All comments and responses are anonymous and will be treated confidentially. There are three sections in the survey as shown in Table 3.1:

i. **SECTION A:** This section sought data on the respondents' function, personal information, education, size of the team and project and personal influencers. Fourteen questions are raised in this section.

ii. **SECTION B:** In this part we tried to focus on the success factors and their existence in the projects. We asked the questions to determine the adherence of success indicators in 5 dimensions (people, organization, process, technical and process) and their sub factors. Answers are asked in a five point Likert schema (Strongly disagree, Disagree, Neither agree nor Disagree, Agree, Strongly agree) Number of questions are forty nine in this section. (There are also double check questions for the same factor to check the consistency. When they are ignored, questions are around 35)

iii. **SECTION C**: for additional comments, or feedbacks to be entered on a free text area.

Table 3.1: Survey form

Section A: Personal Information and Experience
Q1:
Q2
Q..
SECTION B: Success Factors
Q1-Qx: Sub Factor1
Qx-Qy: Sub Factor 2
Q..
Section C: Additional comments or feedbacks

Then analysis methods are used to evaluate the results of the survey to build a model for determining the impacts of the success factors.

3.2 DATA SET AND ANALYSIS

After publishing the online survey to the people that apply agile methods and collecting the data, we focus on the data analysis methods to build the man data set. That data set is used in building the multi dimensional view of the success factors and validate their existence in agile projects.

To calculate the degree of impact in one factor there is two-step process applied to get the final data set. First we transform the 5-point Likert scale results into scores of 1 to 5 with below mappings as shown in Table 3.2:

Table 3.2 Response scores

Responses	For positively phrased questions	For negatively phrased questions
Strongly Agree – definetely important	5	1
Agree – important	4	2
Neither Agree or Disagree – neutral	3	3
Disagree – unimportant	2	4
Strongly Disagree – definetely unimportant	1	5

Then we need to normalize the data and to have below mappings and convert to general 100 point scale for calculations.

5 -> 100

4 -> 75

3 -> 50

2 -> 25

1 -> 0

We have collected responses from 179 participants and map all the responses to general 100 point scale.

Before starting evaluation there is one last step required which is getting the average score of the responses of each question under a specific sub-criteria. This is required as there are more than one questions that maps to a sub-criteria so we need the average value of the responses.

You can think of an example that there are two questions for sub-criteria 1 with the answers of 100 and 50. So average value for thar criteria shall be 75. After this step we get the proper data set that we can apply to a model directly.

3.3 METHODS

We have focused on PLS methods for determining the existence and impacts of success factors in agile project which are PLS-SEM and PLS-PM (Partial Least Squares – Path Modeling) methods.

Hair and others (2014) states that the these two methods can be used to model the complexity of cause-effect relationships among the latent variables. Vinzi and others (2010) highlights PLS PM aims to increase the number of variances rather than accuracy of the statistical estimates so it does not provide a covariance matrix.

The description of the modeling is based on two models: the outer model (also called the measurement model) and the inner model (also called the structural model). The outer model measures the correlation of the manifest variables (MV) to their latent variables (LV) and the inner model endogenous latent variables to other latent variables.

Lee and others (2011) describes the algorithm that provides the structural equation model and determines the estimates of LVs in alternating steps, by using the inner and outer models. The outer mode performs calculations on LVs using the weighted sum of its MVs. The inner model performs calculations on LVs using the linear regression between LV and MVs. This calculations are performed repeatedly until proper convergence results are received.

Peng and Lai (2012) makes the definition of a LV as a construct (an unobservable, indirect variable) which are constructed with observable, measurable, direct variables, formulized as xh which are the inidicators or MVs. Sarstedt and others (2014) describes the ways of determining the latent variables with their manifest variables which are indicated with three methods; reflective way, formative way and the Multiple effect Indicators for Multiple Causes way (MIMIC).

In this study, reflective way has been used for the analysis.

3.3.1 The Reflective Way

In this way each latent variable is reflected by its manifest variables. This reflection is related by a simple regression for each of the manifest variables.

$$X_h = \pi_{h0} + \pi_h \xi + \varepsilon_h, \quad \textbf{(3.1)}$$

which ξ has mean value of m and its standard deviation of 1. In the reflective way: MVs reflect its LVs, namely x_h reflects ξ.

Theoricaly, manifest variable blocks are unidimensional if we evaluate the factor analysis in the reflective way. However it has to be checked in the practical data set.

Three different methods are used to validate the unidimensionality of the manifest variable blocks: principal component analysis of a block method, Cronbach's a and Dillon-Goldstein's r.

a. Principal component analysis of a block

The first eigenvalue of the correlation matrix should be >1 and the second one should be far from the value of the first one or <1 for a specific group of MV. If it is so, that group of MV is evaluated as unidimensional.

b. Cronbach's α

If the block of x_h values are all positive, meaning that their correlation is also positive, Cronbach's α is the method that can be applied to validate unidimensionality. If the block of the MV is >0.7 then it is unidimensional. Cronbach formula is below:

$$\alpha = p / (p-1) \left[\Sigma_{h \neq h'} cor(x_h, x_{h'}) / (p + \Sigma_{h \neq h'} cor(x_h, x_{h'}))\right] \quad \textbf{(3.2)}$$

c. Dillon-Goldstein's r

If the correlation is positive and also all the loadings are positive, then Goldstein-Dillon's r can be applied. If all the loadings are large, then block will be unidimensional. The Goldstein-Dillon's r formula is:

$$r = (\Sigma h=1..p\pi h)^2 Var(\xi) / [(\Sigma h=1..p\pi h)^2 Var(\xi) + \Sigma h=1..p\varepsilon h] \quad \textbf{(3.3)}$$

PLS Path Modeling is based on two main principals which are prior knowledge and data analysis and is a mixture of these two disciplines.

In the reflective way, if the data does not fit the model and could not validate the unidimensionality, they can be removed from the model by deleting some MVs. This helps to eliminate the MVs that does not fit the model. Alternative solution applied is to use the formative way.

3.3.2 The Formative Way

The LV ξ is generated by its own MVs. The LV ξ is a linear function of its MVs plus a residual term:

$$\xi = \Sigma hwhxh + \delta \quad \textbf{(3.4)}$$

In the formative model the block of manifest variables can be multidimensional.

3.3.3 The Mimic Way

The MIMIC way is a mixture of earlier ways. The block model is formulized as below:

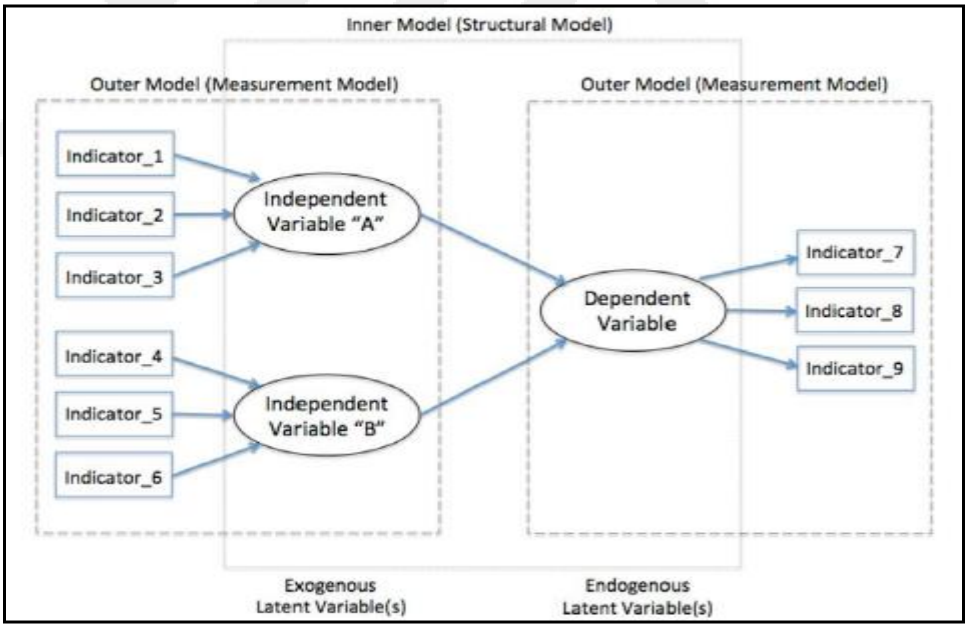
$$xh = \pi h0 + \pi h\xi + \varepsilon h, \text{ for } h = 1 \text{ to } p1 \quad \textbf{(3.5)}$$

where the LV is formulized by:

$$\xi = \Sigma h{=}p1{+}1 \ whxh + \delta h \tag{3.6}$$

Many IS researchers have recommended PLS for data analysis, claiming that PLS yields more accurate estimates for path coefficients than those provided by SEM, especially when the sample size is smaller. Kwong and Wong (2013) describes SEM based on two models, the outer and the inner models. As shown in Figure 3.1, outer model shows the relationship between LVs and their observed MVs where structural model shows the relationship between dependant and independant LVs. In this study, PLS-SEM and PLS PM has been applied for modeling and analysis.

Figure 3.1 PLS SEM Diagram



Source: Wong, K., and Kwong, K., 2013. Pls-sem techniques using smartpls.

We used a free popular tool of EXCEL namely XLSTAT for implementing our PLS-models. XLSTAT is developed first in 1993 and become a powerful statistics and analysis tool used as an add-in for MS Excel. XLSTAT is an easy, user-friendly and effective statistical data analysis tool.

In order to apply a model in XLSTAT, we need the data set mapped to the success factors that has been proposed earlier. For each of the question, we determined which sub-criteria the response can be mapped to. That enables us to calculate the score for each sub-criterias. Table 3.3 shows the mapping between questions and corresponding sub-criterias. If there are more than one questions adressing a criteria, the average scores of the questions are calculated. According to Table 3.3 mean score of each sub-criteria has been calculated and used in the model.

Table 3.3 Criteria and question mappings

Criterias				Adopted From	Questions
C1			**Organizational**		
			Management Commitment		
	C1.1	O1	Strong executive support	Mansor et al, 2014 Nasir and Sahibuddin, 2011 Wan and Wang, 2010 Abdulaziz and Mayhew, 2013	17
		O2	Committed sponsor or manager		18
			Organizational Environment		
	C1.2	O3	Cooperative organizational culture instead of hierarchal	Nasir and Sahibuddin, 2011 Charette, 2005 Cockburn and Highsmith,2001 Mansor et al, 2014	19
		O4	Organizations where agile methodology is universally accepted		20
		O5	Facility with proper agile-style work environment		22
			Team Distribution		
	C1.3	O6	Collocation of the whole team	Nasir and Sahibuddin, 2011 Mansor et al, 2014 Oferi, 2013	23
		O7	Team size being too large		25
C2			**People**		
			Knowledge and Experience		
	C2.1	P1	Team members with high competence and expertise	Nasir and Sahibuddin, 2011 Oferi, 2013 Chow and Cao, 2008 Abdulaziz and Mayhew, 2013 Cockburn and Highsmith,2001	28-52
		P2	Managers knowledgeable in agile process		32-35
			Team behavior		
	C2.2	P3	Team members with great motivation	Mansor et al, 2014 Wan and Wang, 2010 Misra, 2006 Abdulaziz and Mayhew, 2013 Cockburn and Highsmith,2001	31-33-34-36
		P4	Coherent, self-organizing teamwork		37-45
		P5	Oral culture placing high value on face-to-face communication		21
C3			**Process**		
			Requirements and Planning		
	C3.1	Pro1	Clear and well understood project scope and requirements	Chow and Cao, 2008 Misra, 2006 Nasir and Sahibuddin, 2011 Cockburn and Highsmith,2001	40-60
		Pro2	Accurate sizing/design estimate		57-64
			Customer role		
	C3.2	Pro3	Strong customer commitment and presence	Mansor et al, 2014 Wan and Wang, 2010 Misra, 2006 Abdulaziz and Mayhew, 2013	15-16-26
		Pro4	Customer having full authority		38-39-56-61
		Pro5	Good customer relationship		27-29-30
			Tracking Tools		
	C3.3	Pro6	Following agile-oriented process	Nasir and Sahibuddin, 2011 Wan and Wang, 2010	41-62-63
C4			**Technical**		
			Technology		
	C4.1	T1	Well-defined coding standards up front	Mansor et al, 2014 Wan and Wang, 2010 Cockburn and Highsmith,2001 Abdulaziz and Mayhew, 2013	42-43
		T2	Pursuing simple design		45
		T3	Rigorous refactoring activities		44
		T4	Right amount of documentation		46-47
			Infrastructure		
	C4.2	T5	Regular delivery of software	Chow and Cao, 2008 Mansor et al, 2014 Cockburn and Highsmith,2001 Nasir and Sahibuddin, 2011	48
		T6	Delivering most important features first		49
		T7	Correct integration testing		50-51-54
		T8	Appropriate technical training to team		53
C5			**Project**		
	C5.1		**Project Type**		
		Pt1	Project type non being of variable scope with emergent requirement	Nasir and Sahibuddin, 2011 Wan and Wang, 2010	49-56
		Pt2	Projects with up-front cost evaluation done		64
			Project Size		
		Pt3	Projects with small team	Cockburn and Highsmith,2001 Nasir and Sahibuddin, 2011 Misra, 2006	58
		Pt4	Projects with no multiple dependent teams (such distributed international projects)		24-59
C6			**Success**		
	C6.1	S1	Perceived Quality		55
		S2	On time delivery		48

4. FINDINGS

By using the XLSTAT, the initial PLS model has been constructed as shown in Figure 4.1.1., based on the data collected with online survey and the literature search.

As described earlier, in Figure 3.3.1, there has been two models in PLS SEM analysis. In first step, initial model has been built and reliability analysis has been performed on the model. Then depending on the reliability results, model has been re-constructed to build the final model. In second step, validity analysis has been tested on the final model and results evaluated.

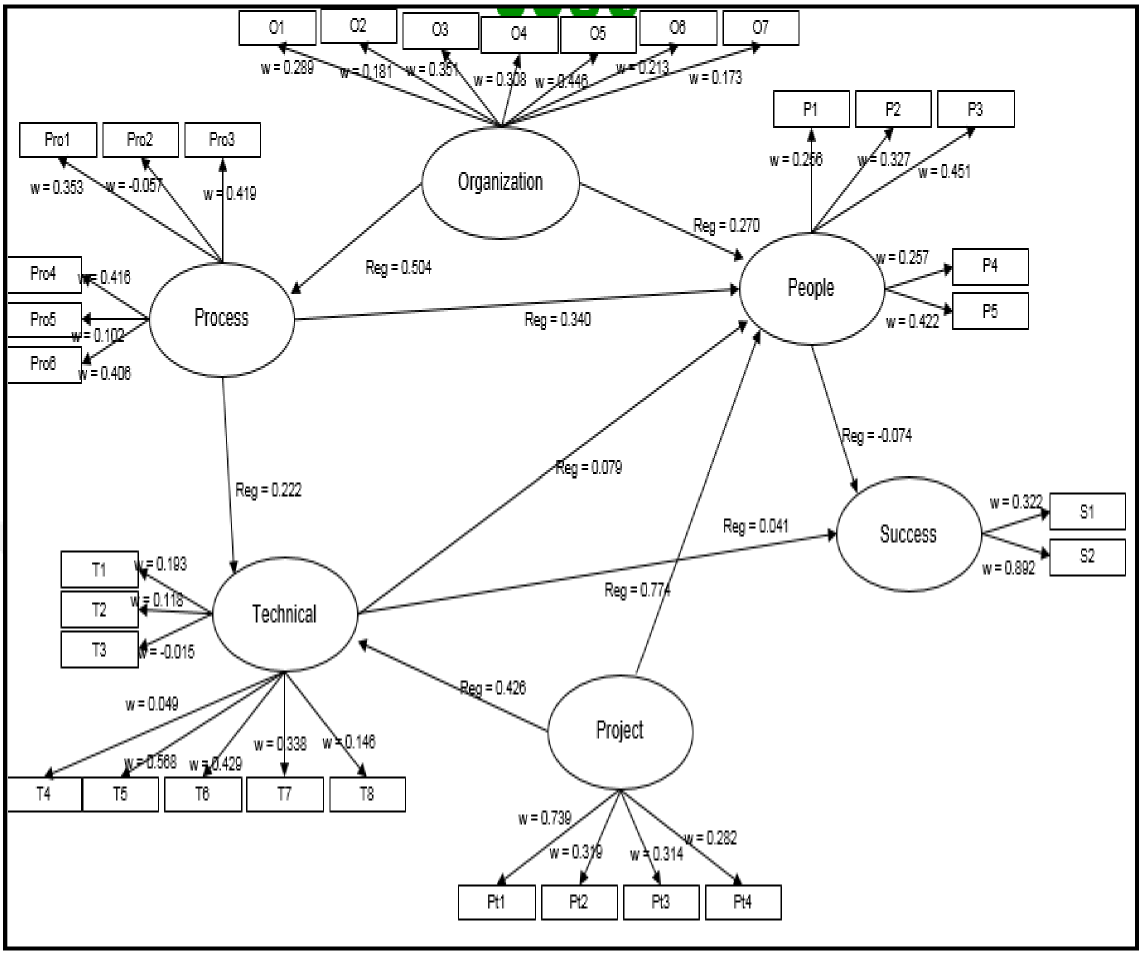
4.1 THE OUTER MODEL (MEASUREMENT MODEL)

There are 5 main CSFs as shown as LVs (Latent Variables) in the initial model: Organization, People, Process, Technical and Projects as shown in Figure 4.1. And an exit factor has been determined namely as “Success Factor” and also shown as LV.

For each LV, sub-criterias of the factors are added as Manifest Variables (MV) to the LVs. O1 to O7 are mapped to seven survey questions (From Table 3.3) regarding the Organizational Factors respectively and added as MVs of the Organization LV. Similarly P1 to P5 (From Table 3.3) are the MVs of People factor: Pro1 to Pro 6 (From Table 3.3) are the MVs of Process factor: T1 to T8 (From Table 3.3) are the MVs of Technical factor: Pt1 to Pt4 (From Table 3.3) are the MVs of Project factor and lasty S1 and S2 (From Table 3.3) are the MVs of the exit factor, which is Success factor.

Reflective measurement model has been used in this study. Hair et al. (2013) states that if correlations of the factors are high and inter changeable, it means factors may be reflective and reliability and validity analysis should be performed.

Figure 4.1 Initial PLS PM model



4.1.1 Reliability Analysis

Reliability analysis used to validate the scale which should reflect the construct if it is measuring consistently. In PLS, it is used to validate the LVs and the MVs are good to go for further analysis by means of reliability. Especially which the meat data is get by using a survey or questionarie, respondents may interpret the questions differently and answers may differ a lot. By performing reliability analysis, mistakable questions can be revealed.

After executing the initial model, two step analyses has been performed on the findings. First the outer model then the inner model is validated. Factor analysis has been used to assess the construct validity which is a detemination of whether the measure of the item is similar within itself and yet sufficiently different from other items. If constructs are valid, there should be high correlations (>0.5) between measures of the same construct.

Composite reliability (Monofactorial manifest variables), shows the internal consistency by using cross loadings, Cronbach's Alpha (1971) and D.G. Rho values. Cronbach's alpha takes into account that the equal weighting of the indicators whereas the empirical model, D.G Rho, assumes indicators are unequally weighted. Bagozzi and Yi (1988) defines, for Cronbach's Alpha, 0.4 or higher for explanatory research and 0, 70 or higher for factor reliability. And for D.G. Rho, 0, 60 or higher for explanatory research and 0, 70 or higher for composite reliability.

In the inital model, Cronbach's Alpha and D.G Rho can not be computed so validity check has been performed with cross loadings. Table 4.1 shows the cross loading values of the initial model.

Cross loadings are used to determine the effectiveness of each factor on the other factors (non-target). It is one of the methods used to decide the MVs are effective enough on the LVs and further analysis can be performed on the model or not.

If constructs are valid, there should be high correlations (>0.5) between cross loadings of the same construct. If constructs are not valid, they can be removed from the model to construct a better model with high validity.

Table 4.1 Cross loadings of initial model

	Organizatioı	Process	People	Technical	Project	Success
O1	**0.250**	0.283	0.185	0.190	0.287	0.073
O2	**0.419**	0.144	0.150	0.134	0.046	0.089
O3	**0.527**	0.336	0.234	0.301	0.177	0.351
O4	**0.610**	0.267	0.232	0.195	0.206	0.175
O5	**0.705**	0.307	0.416	0.090	0.177	0.076
O6	**0.431**	0.173	0.173	0.113	0.172	0.107
O7	**0.420**	0.132	0.149	0.180	0.048	0.078
Pro1	0.269	**0.479**	0.434	0.095	0.183	0.020
Pro2	-0.091	**-0.197**	-0.077	0.039	0.045	0.062
Pro3	0.335	**0.666**	0.313	0.298	0.380	0.280
Pro4	0.355	**0.636**	0.287	0.299	0.368	0.219
Pro5	0.022	**0.200**	0.035	0.173	0.097	0.241
Pro6	0.281	**0.629**	0.293	0.343	0.298	0.269
P1	0.186	0.244	**0.533**	0.150	0.177	0.025
P2	0.315	0.340	**0.522**	0.077	0.187	0.079
P3	0.327	0.380	**0.728**	0.278	0.294	0.097
P4	0.115	0.332	**0.415**	0.211	0.059	0.069
P5	0.366	0.238	**0.609**	0.232	0.220	0.230
T1	0.063	0.179	0.167	**0.333**	0.131	0.096
T2	0.030	0.074	0.209	**0.195**	-0.029	0.096
T3	0.067	0.033	0.080	**-0.099**	0.032	-0.188
T4	-0.047	0.006	-0.075	**0.294**	0.035	0.179
T5	0.238	0.308	0.172	**0.759**	0.260	0.948
T6	0.228	0.246	0.127	**0.583**	0.629	0.271
T7	0.166	0.257	0.347	**0.530**	0.259	0.140
T8	0.264	0.188	0.139	**0.253**	0.073	0.034
Pt1	0.334	0.498	0.293	0.500	**0.844**	0.265
Pt2	0.092	0.112	0.160	0.183	**0.376**	0.157
Pt3	0.088	0.211	0.134	0.203	**0.417**	0.113
Pt4	0.132	0.126	0.134	0.169	**0.444**	0.070
S1	0.221	0.222	0.116	0.221	0.214	**0.477**
S2	0.238	0.308	0.172	0.759	0.260	**0.948**

From the results, it is observed that there are many factors do not meat the expected 0.5 value. For example the O1 factor did not load well on the organization factor (loading < 0.5), it is deleted from the model. From Table 4.1, there has been many constructs, highlighted in yellow in the table, did not show satisfactory discriminant validity because the loadings of indicators on their assigned construct were not much higher than their loadings on other constructs.

These indicators are deleted from the model (yellow highlighted in Table 4.1) and model has been re-executed.

This operation is performed repetedly with each results until there has been noticed improvement on the construct validity of the indicators. Latest results of the execution are shown below.

Table 4.2 Cross loadings of final model

	Organizatio	Process	People	Technical	Project	Success
O3	**0.518**	0.293	0.273	0.309	0.166	0.335
O4	**0.551**	0.250	0.269	0.279	0.192	0.214
O5	**0.892**	0.270	0.380	0.108	0.163	0.118
O6	**0.898**	0.287	0.382	0.101	0.193	0.113
Pro2	0.290	**0.726**	0.523	0.263	0.226	0.239
Pro3	0.266	**0.642**	0.249	0.378	0.403	0.309
Pro4	0.230	**0.517**	0.209	0.226	0.407	0.200
Pro6	0.232	**0.776**	0.292	0.463	0.246	0.257
P2	0.326	0.362	**0.541**	0.117	0.159	0.085
P3	0.270	0.370	**0.841**	0.158	0.290	0.082
P4	0.227	0.330	**0.816**	0.162	0.287	0.083
P5	0.396	0.234	**0.592**	0.219	0.217	0.235
T3	0.258	0.452	0.188	**0.681**	0.241	0.572
T5	0.143	0.356	0.187	**0.709**	0.217	0.831
T6	0.107	0.275	0.129	**0.674**	0.699	0.302
Pt1	0.235	0.461	0.316	0.564	**0.950**	0.282
Pt4	0.100	0.164	0.205	0.157	**0.508**	0.060
S1	0.245	0.207	0.095	0.570	0.193	**0.692**
S2	0.143	0.356	0.187	0.709	0.217	**0.831**

Based on the fact that if constructs are valid, there should be high correlations (>0.5) between cross loadings of the same construct, which in the final model cross loadings of the MVs are all higher than 0.5. From Table 4.2 and Table 4.3 all constraints demonstrate good converged validity (>0.5). Also with the improved final model, composite reliability results has been able to taken.

Table 4.3 Composite reliability of final model

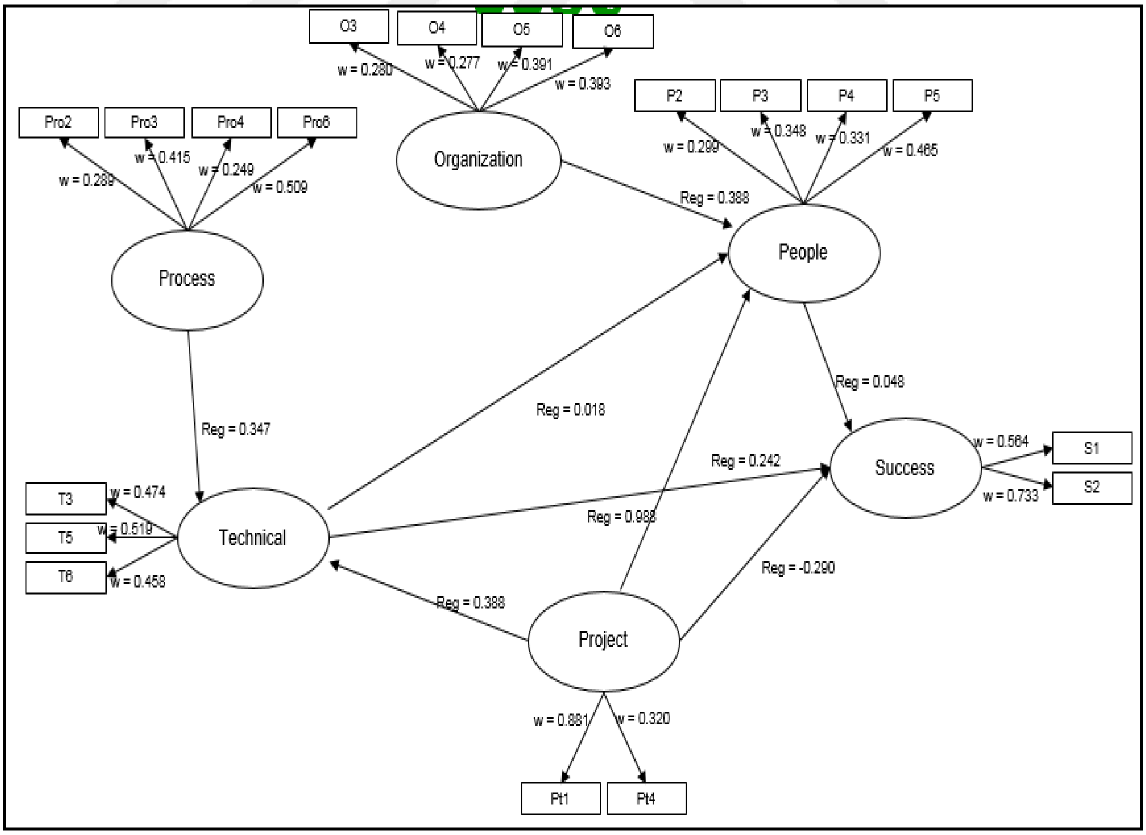
Latent variable	Dimensions	Cronbach's alpha	D.G. rho (PCA)	Condition number	Critical value	Eigenvalues
Organization	4	0.691	0.813	7.923	1.000	2.189
						1.065
						0.711
						0.035
Process	4	0.599	0.768	2.042	1.000	1.839
						1.006
						0.714
						0.441
Project	2	0.352	0.755	1.242	1.000	1.214
						0.786
Technical	3	0.446	0.730	1.357	1.000	1.423
						0.805
						0.773
People	4	0.659	0.801	6.664	1.000	2.168
						0.957
						0.826
						0.049
Success	2	0.297	0.740	1.192	1.000	1.174
						0.826

As stated earlier, D.G Rho is preferable to determine the composite reliability as it assumes the unequality of the constructs. (whereas Cronbach’s alpha assumes equality). Bagozzi and Yi (1988) defines, for Cronbach’s Alpha, 0.4 or higher for explanatory research and 0, 70 or higher for factor reliability. And for D.G. Rho, 0, 60 or higher for explanatory research and 0, 70 or higher for composite reliability. Table 4.3 shows that all the factors have achieved >0.70 D.G Rho values with Organization, Process and People factors achieves >0.50 Cronbach’s alpha and Technical factor achieved >0.40 CA as well.

Also the block of Eigenvalues for each LV is bigger than the former execution so MV blocks of each LV is verified to be unidimensional. This means reliability of the model is satisfactory and can be used as further verification.

The latest PLS PM Model with reliable and valid constructs are shown in Figure 4.2:

Figure 4.2 Final PLS PM model



After checking the reliability of the model, it has been considered as the "final model" in the remaining parts of this study. Final model is confirmed reliability analysis with cross loadings first and now further analysis can be performed on the model.

4.1.2 Validity Analysis

In statistics, validity means exact and precise results received from the meta data. A measure from sample with correct conclusions can provide a model that can be applied to the whole population.

Validation in a measurement model built by a reflective model can be performed with discriminant and convergent validity. In PLS SEM, converged validity reflects to which extent that MV is related to LV.

Hair and others (2010) states for discriminant validity that assures a factor measurement to be unique and representative of the best measurement. Fornell & Larcker (1981) recommends AVE (average variance extracted) comparisons to validate the discriminant validity of the factors in the model. AVE value to be 0.50 and higher indicates the LV explains more than 50 percent of indicator variances.

Table 4.4 shows the outer weights and AVE values for the LVs in the final model. Outer weights with AVE index values describes the relation between each MV and its LV and can be seen that other than Process and Technical factors, all are >0.50 meaning that those LVs explain more than 50 percent of its indicator variances.

Even for process and technical factors, AVE index is so close to 0.50 so it was concluded that the discriminant and convergent validity is validated and all the LVs are influental with their MVs.

Table 4.4 Discriminant validity of final model

Latent variable	Manifest variables	Outer weight	Mean Communalities (AVE)
Organization	O3	0.280	
	O4	0.277	
	O5	0.391	
	O6	0.393	0.544
Process	Pro2	0.289	
	Pro3	0.415	
	Pro4	0.249	
	Pro6	0.509	0.482
People	P2	0.299	
	P3	0.348	
	P4	0.331	
	P5	0.465	0.580
Technical	T3	0.474	
	T5	0.519	
	T6	0.458	0.494
Project	Pt1	0.881	
	Pt4	0.320	0.504
Success	S1	0.564	
	S2	0.733	0.585

The outer weights determines the effect of MV in measuring the LV and the standartized loadings.

From the outer weight validation, it is observed that Pt1 – Project type non being of variable scope with emergent requirement is the driver in Project factor. For the process factor, Pro6 – Following agile-oriented process is dominant anong the other MVs. P5 – Oral culture placing high value on face-to-face communication is the most significant MV for people factor. T5 – Regular delivery of software seems as the most effective factor but close with the other two MVs, T3 – Rigorous refactoring activities and T6 – Delivering most important features first. For the organization factor, there is no dominant factor observed but O5 – Facility with proper agile-style work environment and O6 – Collocation of the whole team.

4.2 THE INNER MODEL (STRUCTURAL MODEL)

After validating the outer model, inner model has been analysed. The structural model describes the relativity between the LVs that the model is built on. An indicator in SEM can either be endogenous or exogenous. An exogenous variable has correlation showed with path arrows that none leading to it and it leads outwards. Whereas an endogenous variable has one path, at least, that represents the correlation towards to it.

In validation of the structural model, R^2 measures and path coefficient values are used. As PLS-SEM method tries to determine the relations of the endogenous LVs and prediction oriented approach is being used in building the models, R^2 values are expected to be high enough to meet the purpose. Expected values for R^2 depends on the discipline of the research. To determine the success drivers, $R^2 > 0.75$ is evaluated as high whereas 0.20 nay evaluated as high in determining the consumer behaviors. This study focuses on determining the success indicators of agile projects, 0.75 will be used as the reference value in R^2 squares.

Another validation in structural model is using the Goodness of Fit (GoF Index) value measures the relativity among the variance and covariance from the sample matrix. GoF Index measures the relativity and is one of the ways to determine the model fit. Schermelleh-Engel et al. (2003) states that the GoF Index should be 0-1 where closest values to 1 are considered as good model fits. In this section, first the complete model has been evaluated then the data is filtered by the project size of being large, medium and small and another evaluation has been done.

4.2.1 Complete Model Evaluation

In the final model, as shown in Table 4.5, absolute GoF index is 0.493 with relative GoF as 0.850. It has been observed that the absolute GoF index of initial model was 0.321 which did not evaluate as good fit to the model. (Although the relative GoF was 0.754)

Table 4.5 Goodness of fit indexes of the complete model

	GoF	GoF (Bootstrap)	Standard error
Absolute	0.493	0.498	0.028
Relative	0.850	0.834	0.035
Outer mo	0.985	0.978	0.032
Inner moc	0.862	0.852	0.021

As indicated earlier, GoF Index measures the relativity among the variance and covariance from the sample matrix and is one of the ways to determine the model fit. After reliability of the factors are improved with some removements, GoF index has been raised to 0.493 (early 0.50) with relative GoF as 0.850. This indicates that we now have a “good” fit with the model.

Table 4.6 illustrates the model assessment. Organization, Process and Project are evaluated as the exogenous factors whereas technical, people and success are the endogenous factors. As success factor was used as the exit criteria, it should be endogenous which fits with the model. R^2 values of the endogenous factors are: 0.395 technical, 0.262 people and 0.763 success with mean R^2 0.473.

Table 4.6 Model assessment

Latent variable	Type	R^2	Adjusted R^2	Mean Communalities (AVE)	D.G. rho
Organization	Exogenous			0.544	0.818
Process	Exogenous			0.452	0.764
Project	Exogenous			0.580	0.717
Technical	Endogenous	0.395	0.391	0.474	0.730
People	Endogenous	0.262	0.254	0.504	0.797
Success	Endogenous	0.763	0.760	0.585	0.737
Mean		0.473		0.513	

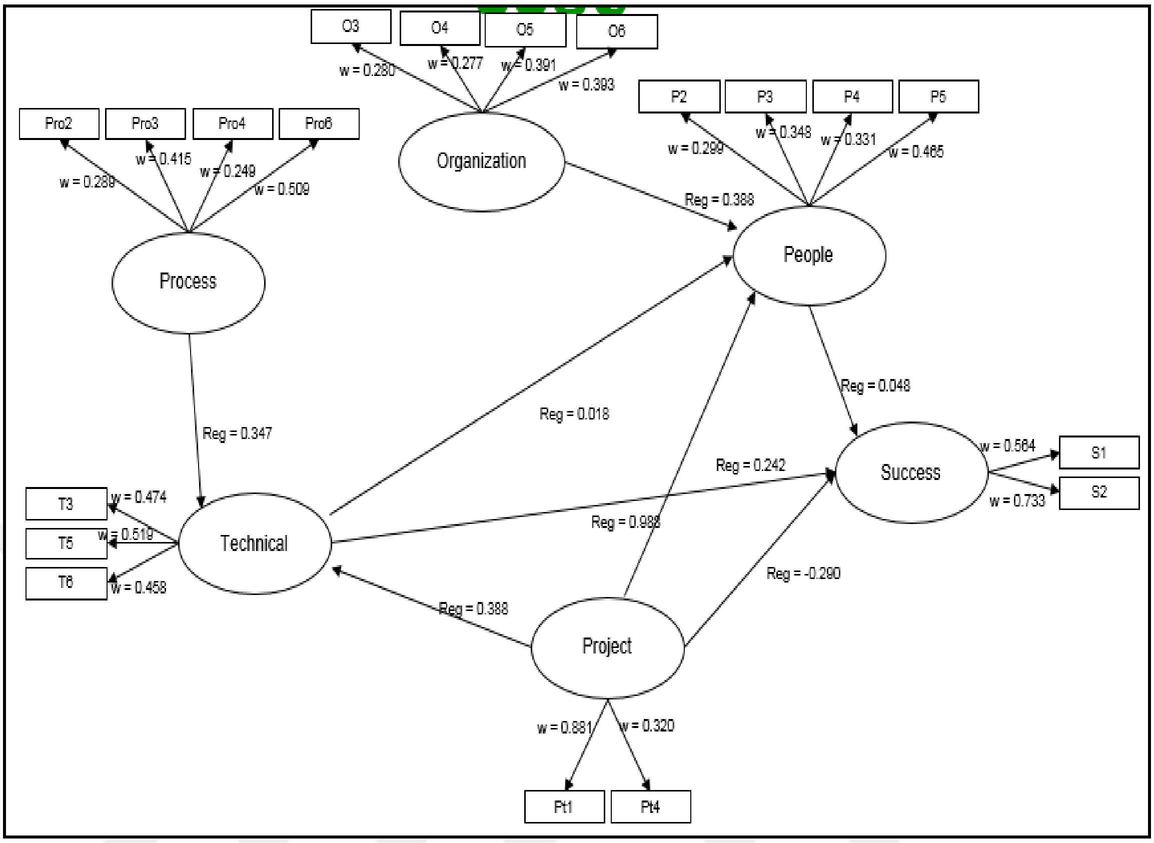
Table 4.7 R square of success

R^2	F	Pr > F	R^2(Bootstrap)
0.763	180.159	0.000	0.759

As shown in table 4.7, for the success criteria with R^2 of 0.763, it is considered as substantial result as it is > 0.75 (Hair et al. 2011) which was referenced to determine the drivers. Another evaluation of the result is 76 percent of the factor can be explained with selected contributors.

Path loadings and R^2 values is shown in Figure 4.3.

Figure 4.3 Path loadings and R² values of the final model



Based on the aim of this study, success factor can be explained with three main contributors which are Technical, Project and People. And defines the success factor mostly based on technical factors (with correlation of 0.984) and project factors (with correlation of -0.290) with relatively small effect on people factors (with correlation of 0.048).

Path coefficients and impact of the contributors of success are shown in Table 4.8 and Table 4.9 respectively.

Table 4.8 Impact and contribution of the variables to success factor

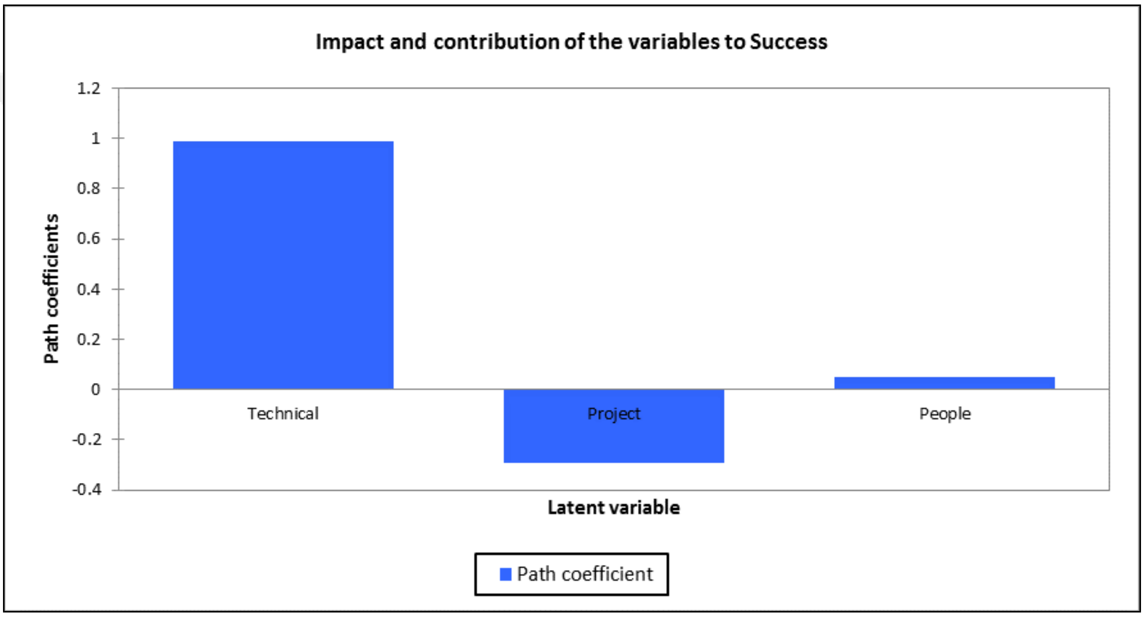
	Technical	Project	People
Correlation	0.841	0.268	0.191
Path coefficient	0.988	-0.290	0.048
Correlation * patl	0.831	-0.078	0.009
Contribution to R² (%)			
Cumulative %			

Table 4.9 Path coefficients of success factor

Latent variable	Value	Standard error	t	Pr > |t|	f²	Value(Bootstrap)	Standard error(Bootstrap)
Project	-0.290	0.046	-6.228	0.000	0.231	-0.281	0.056
Technical	0.988	0.045	21.950	0.000	2.868	0.980	0.037
People	0.048	0.040	1.191	0.235	0.008	0.051	0.040

The equation for success is, Success= -0.290*Project+0.988*Technical+0.483* People
And it can be illustrated in Figure 4.4 below

Figure 4.4: Impact and contribution of the variables to Success



4.2.2 Model Analysis By Project Size

The analysis has been re-evaluated based on the project size, where respondents in the survey specified at the beginning that their expertise on agile projects, whether it is Small/Very Small (schedule of 3 – 6 months / 10 – 20 headcount in the project), Medium (schedule of 6 months – 1 year / 20 – 30 headcount in the project) or Large (schedule of more than one year / 30+ headcount in the project).

Table 4.10 lists the structural model data by project size.

Table 4.10 Structural model data by project size

		Large		Medium		Small	
Latent variable	Type	R^2	AVE	R^2	AVE	R^2	AVE
Organization	Exogenous		0.529		0.328		0.423
Process	Exogenous		0.390		0.329		0.363
Project	Exogenous		0.746		0.505		0.559
Technical	Endogenous	0.613	0.558	0.580	0.398	0.274	0.486
People	Endogenous	0.355	0.357	0.175	0.240	0.356	0.373
Success	Endogenous	0.447	0.685	0.695	0.673	0.695	0.562
Mean		0.471	0.507	0.483	0.376	0.442	0.439

As it can be seen above, the R^2 of the success factor has been decreasing from small to large projects which is meaningful as it will be more complex to explain the success factors in larger projects. Also the people factor is more effective on small and large projects, but it is slightly decreases in medium projects. This may be explained that it will be harder to build synergy within the small teams and the larger teams. And the technical factor is the most challenging factor in large projects with R^2 of 0.613 where loses effect when going to small size projects with R^2 of 0.274.

In order to explain the success indicators based on project size, correlation coefficients shown in Table 4.11.

Table 4.11 Success factor correlations by project size

	Large			Medium			Small		
	Tech	Project	People	Tech	Project	People	Tech	People	Project
Correlation	0.238	-0.072	-0.358	0.809	0.483	0.294	0.783	0.242	0.202
Path coefficient	0.776	-0.294	-0.674	1.031	-0.312	0.042	0.919	0.187	-0.342
Correlation * path coefficient	0.184	0.021	0.241	0.834	-0.151	0.012	0.719	0.045	-0.069

Correlation of the people increases from small to large projects however evaluated has negative impact in large projects. In opposite, technical factors has evaluated as low impact on large projects, whereas has slightly higher impacts on medium and small projects. Project factor has negative impact for the success of large projects which project factor is consists of project size and type and increased project size has evaluated as negative impact for the success. Lastly, model evaluation of the GoF index for different project sizes are shown in Table 4.12 below.

Table 4.12 GoF indexes by project size

	Large		Medium		Small	
	GoF	GoF (Bootstrap)	GoF	GoF (Bootstrap)	GoF	GoF (Bootstrap)
Absolute	0.489	0.582	0.426	0.466	0.440	0.453
Relative	0.672	0.735	0.779	0.763	0.802	0.784
Outer model	0.940	0.881	0.953	0.926	0.979	0.971
Inner model	0.714	0.834	0.817	0.824	0.819	0.807

GoF index is calculated as 0.489 for large projects, 0.466 for medium and 0.440 for small sized projects. It seems that larger project size GoF are much higher than the smaller project sizes.

4.3 DEMOGRAPHIC INFORMATION

Total 179 respondents are attended to the online survey. Figure 4.5 shows that the 72.6 percent of the respondents are male while 27.4 percent are female.

Figure 4.5: Gender of survey respondents

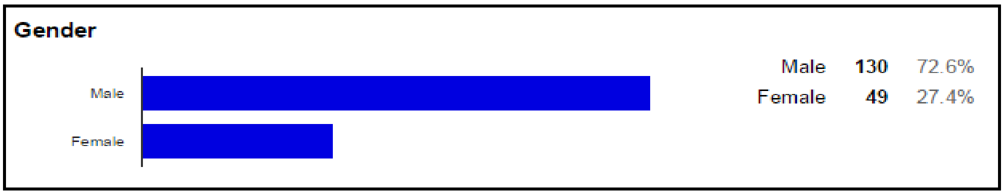


Figure 4.6 shows that the respondents are in different roles from project manager to agile coach. Almost half of them are in designer role in a scrum. Most survey respondents describes their agile experience in part of small projects as shown in Figure 4.7. From the demographic information, we learned that our survey respondents are from a variety of backgrounds and have different roles and experience in agile methodology.

Figure 4.6: Roles of survey respondents

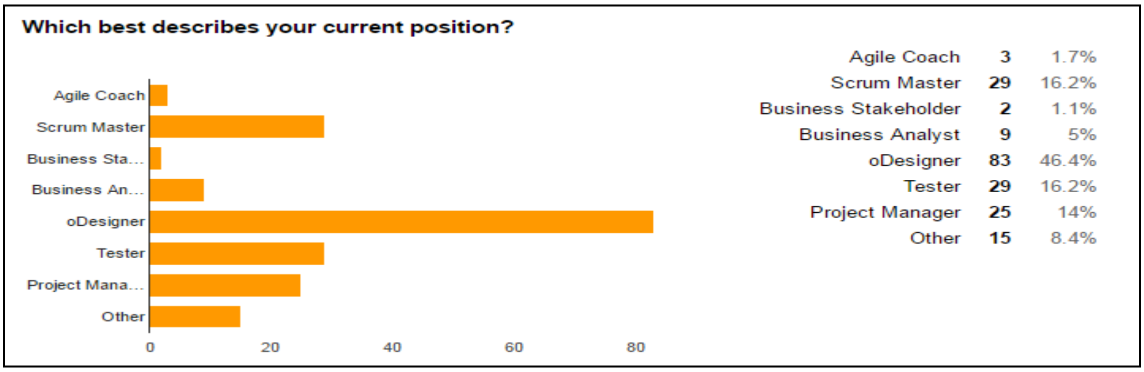
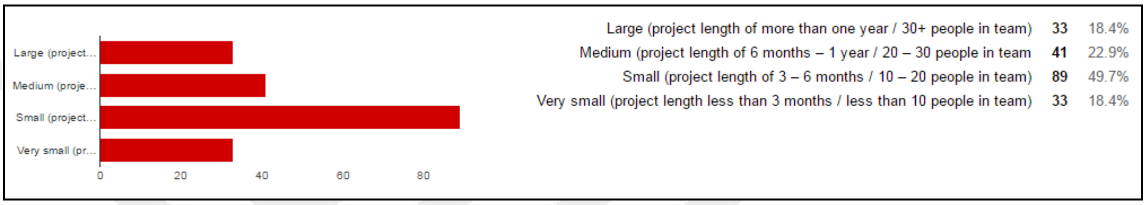


Figure 4.7: Project experience of survey respondents



Also for the exit criteria which is success factor, we observed that respondents strongly believes in frequent delivery, as shown in Figure 4.8, with software quality, as shown in Figure 4.9.

Figure 4.8: Frequent delivery responses

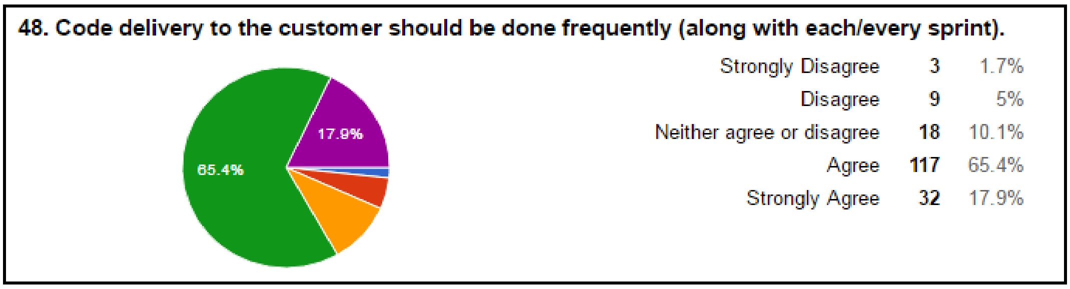
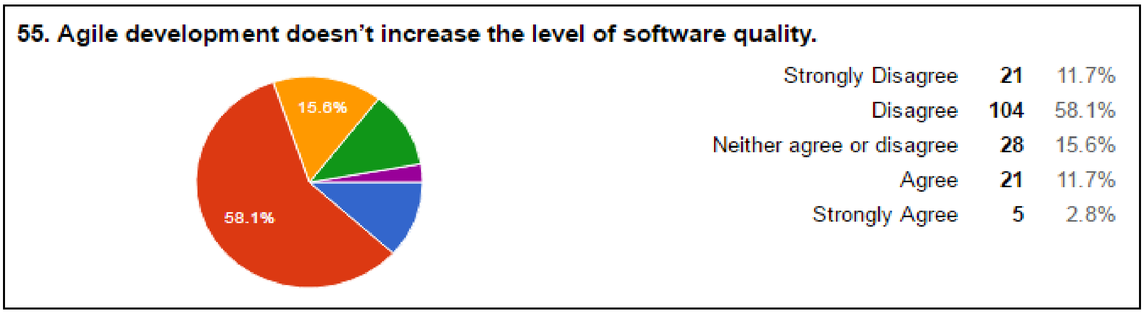


Figure 4.9: Software quality responses

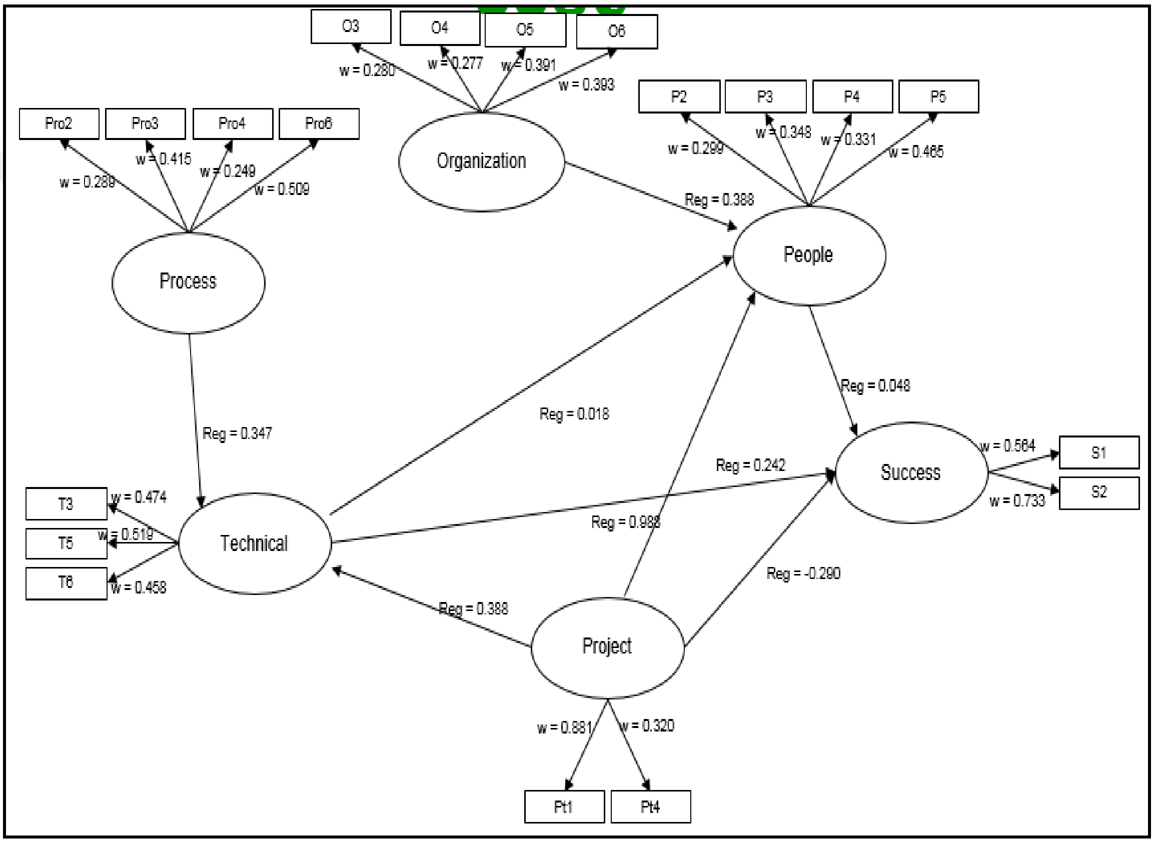


5. DISCUSSION

5.1 SUPPORTED HYPOTHESIS

The results of the final PLS model is shown in Figure 5.1.

Figure 5.1 Final PLS PM model results



The results of PLS analysis supports below hypothesis:

Organizational factors are positively associated with people factors (path coefficient = 0.388) as organization motivates people and encourages team behaviors. Especially organization should recognize the self-initiatives and fast decisions that team takes.

Process factors are positively associated with technical factors (path coefficient = 0.347) as process defines sizing thus starts the planning, the definition of done lists and specifies the technical phases that needs to be included (such as performance analysis, engineering phases etc..) Most importantly customer should be a part of the process and cooperate.

Project factors are positively associated with technical factors (path coefficient = 0.388) as project type determines the technology for the software and project size determines the infrastructure that needs to be built up.

People factors are positively associated with success factor of an agile project (path coefficient = 0.048) as people develops the project.

Project factors are negatively associated with success factor of an agile project (path coefficient = -0.290) as project size and content increases, the success is more challenged.

Technical factors are positively associated with success factor of an agile project (path coefficient = 0.988) as technical factors effects the software quality and regular delivery of software with correct integration testing and documentation.

Success factors can be defined 76 percent on two sub-criterias of delivering the project on time with quality.

In summary, the effect of above factors are large (>0.35) according to the standard suggested in the work of Cohen (1988) for behavioral research.

Sub-criterias that has significant effect on the above factors and supported with this study are also listed in below, Table 5.1.

One of the differenciators of this study is the fact that organizational factors are not evaluated as dominant factors of the success and executive or management support are not supported among the other factors. It can be seen in literature that these factors may be listed among the highest critical factors but when considering that the survey data has been gathered from multinational and non-bureaucratic corporate companies, it may be explained. And instead of management commitment, respondents believe in organizational culture and environment more. Hierarchal organizations does not evaluate as appropriate for agile in the organizational factors.

Table 5.1 Supported Sub-Criterias

Criterias				Impact
C1			Organizational	
	C1.1	Management Commitment		
		O1	Strong executive support	*not supported*
		O2	Committed sponsor or manager	*not supported*
	C1.2	Organizational Environment		
		O3	Cooperative organizational culture instead of hierarchal	**supported**
		O4	Organizations where agile methodology is universally accepted	**supported**
		O5	Facility with proper agile-style work environment	**supported**
	C1.3	Team Distribution		
		O6	Collocation of the whole team	**supported**
		O7	Team size being too large	*not supported*
C2			People	
	C2.1	Knowledge and Experience		
		P1	Team members with high competence and expertise	*not supported*
		P2	Managers knowledgeable in agile process	**supported**
	C2.2	Team behavior		
		P3	Team members with great motivation	**supported**
		P4	Coherent, self-organizing teamwork	**supported**
		P5	Oral culture placing high value on face-to-face communication	**supported**
C3			Process	
	C3.1	Requirements and Planning		
		Pro1	Clear and well understood project scope and requirements	*not supported*
		Pro2	Accurate sizing/design estimate	**supported**
	C3.2	Customer role		
		Pro3	Strong customer commitment and presence	**supported**
		Pro4	Customer having full authority	**supported**
		Pro5	Good customer relationship	*not supported*
	C3.3	Tracking Tools		
		Pro6	Following agile-oriented process	**supported**
C4			Technical	
	C4.1	Technology		
		T1	Well-defined coding standards up front	*not supported*
		T2	Pursuing simple design	*not supported*
		T3	Rigorous refactoring activities	**supported**
		T4	Right amount of documentation	*not supported*
	C4.2	Infrastructure		
		T5	Regular delivery of software	**supported**
		T6	Delivering most important features first	**supported**
		T7	Correct integration testing	*not supported*
		T8	Appropriate technical training to team	*not supported*
C5			Project	
	C5.1	Project Type		
		Pt1	Project type non being of variable scope with emergent requirement	**supported**
		Pt2	Projects with up-front cost evaluation done	*not supported*
		Project Size		
		Pt3	Projects with small team	*not supported*
		Pt4	Projects with no multiple dependent teams (such distributed international projects)	**supported**
C6			Success	
	C6.1	S1	Perceived Quality	**supported**
		S2	On time delivery	**supported**

For the people factor, team competence or expertise is not supported but instead team motivation, self organizing teamwork and open communication seems as more important and supported by the model. Expertise may be covered by hard working, training and mentoring but building trust and cooperation in the team evaluated as more effective for the success. Also project manager’s skillset and agile knowledge evaluated as effective to the success. As this will also effect the team motivation.

Process factors should start with accurate sizing and estimations first and progress should be followed with an agile oriented process. Model supports the hypothesis that customer should be part of the process with its full commitment and presence in the progress.

Technical factors highly rely on the delivery including delivery strategy and methodology. And supports the hypothesis that refactoring activities should be avoided.

And the percentage of the success ratio is evaluated as low when project has a variable scope in its requirements, especially has emergent requirements and requires multiple dependant teams such as distributed, international projects.

5.2 LITERATURE COMPARISON

Chow and Cao has performed a survey study in 2008 and listed proper delivery strategy, software engineering techniques and team capabilities as the top 3 CSFs with project management, team environment and customer involvement as coming next factors. Their data collection method was smilar to this study and was performing an online survey from 109 agile projects and multiple regression techniques were used for data analysis. The results of this study aligns with their results and highlights three main factor as technical, people and project. In this study, technical factors cover delivery strategy and technology and people factor covers team capabilities (top three factors from Chow and Cao).

People factor is specifically focused in Cockburn and Highsmith’s study which is performed in 2001. Team motivation, behavior, environment and self organizing teamwork are all supported in this study which were also highlighted in theirs. Customer involvement and commitment are listed as two of the top three factors in Misra et all in 2006 and also supported in this study.

On the contradictory side, Nasir and Sahubiddin has performed an extensive research among the literature in 2011 and listed top 5 factors depending on their occurrence frequency. Their list includes clear requirements with goals/objectives as the top 2 factors and continues with realistic schedule, high skilled project manager and top management support. This study supports some of the above hypothesis only such as realistic sizing/schedule and project manager knowledgeable in agile but not supports top management or executive support or the clear requirements and goals. Especially support from top management is listed one the top ciritical factors among other CSFs in various other literatures such as Doherty (2012), Wan and Wang (2010) and Abdulaziz and Mayhew (2013) but not supported in our model. This may be because the fact that the survey data is gathered from corporate culture companies where management style is not bureaucratic and management effects are not heavy.

Furthermore, this study has analysed the impact of the project and people factor to the success and provided a detailed model analysed by the size of the projects (large, medium or small). It has been observed in the detailed analysis that the project and people effect turns into negative impact when project size increases by means of number of people, length of the project schedule or both. It is evaluated as when the project size is large, motivating the people around same goal or objectives, breaking the dependencies and keeping the synergy and productivity for longer terms will be more challenging. And when the optimum size can not be kept, possibility of the project to succeed will decrease.

6. CONCLUSION

This paper was an attempt to evaluate the impacts of the CSFs for the agile software development projects and specify the important success criterias based on regression methods applied to a proper data set.

A proposal framework has been presented by modeling the multi dimensional view of the success factors, based on the five categories (people, project, organization, process and technical) with their main and sub indicators. Multi dimensional view narrows down the model and increases readability and applicability.

For the data analysis and method, an online survey has been published to gather the data, analyzed based on 5 likert data schema and used in modeling with PLS-SEM. PLS SEM is a quantitative approach that helps to create a model and perform an analysis to specify the success factors and their relative effects to the success.

The analysis has been performed based on i) Complete model (includes all survey data) ii) Project size grouped model (includes grouped answers from the survey)

In complete model, based on the responses of the survey, success factor has been related with three main factors which are people, project and technical. Technical factors are evaluated as having relatively high association on success and success factors are defined 76 percent on two sub-criterias of delivering the project on time with quality. Technical factor includes technology properties and infrastructure both. Technology determines the development environment with coding standarts that will be followed. And infrastructure includes technical trainings, integration testing, automation, documentation and regular delivery to the customer. All this sub items in technical factor are related with the success of the project. People factor are also evaluated as one of the main factors as in agile projects team synergy, efficiency and output are critical to perform continous delivery to the customer. People factor includes not only the technical skillset and expertise but also communication skills within the team or with the customer. Project factor determines technology based on the content. Also defines the project type such as an integration project or development projects. Project factor has potential impact to the success as depending of the project type, size and nature, success factor may be challenged.

In the model grouped by project size (small, medium and large), we have slightly different results. Small projects model fairly fits with the overall complete model which have technical factors has the highest impact on success followed by people factor and lastly by the project factor. This is mainly because in the survey the most of the respondents have agile experience from small projects. Through small to large size projects, one the factors that differs from the overall complete model is people. In small size projects people factor has limited effect to success however in large size projects, it has increased effect and has negative impact on the success. This may be because in larger projects there are more people and it is more challenging to have more people working on the same project and keep up the synergy and cooperation. Project factor is also changing its impact from positive to negative when project sizes are getting larger. This means when project size and length passes the optimum limits, it effect success negatively and challanges more the project. And in large projects technical factor loses some effect and shares the impact with the people factor.

So, in larger projects, project owners/managers shuld focus people factor more as well as the technical factors to keep up the teams around same goal, with breaking dependencies and motivate and keep up the synergy between the teams. Whereas in smaller projects, technical focus is the dominant factor in success of the project. Success factor is summarized in this study with delivering the feature on time with high quality.

This study provides an emperical model and can be improved with further analysis.

REFERENCES

Books

Cockburn, A., Highsmith, J. 2001. *Agile software development: the people factor*, Issue No.11 - November (2001 vol.34), pp: 131-133, Published by the IEEE Computer Society.

Cohen, J., 1988. S*tatistical power analysis for the behavioral sciences* (2nd ed.), New Jersey: Lawrence Erlbaum Associates, ISBN 0-8058-0283-5, Vol2

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E., 2010. *Multivariate data analysis.* 7th edition. Englewood Cliffs: Prentice Hall.

Hair, J.F., Hult G.T.M., Ringle C.M. and Sarstedt M., 2014. *A primer on partial least squares structural equation modeling (PLS-SEM).* Thousand Oaks, CA: Sage. ISBN 9781452217444.

Highsmith, J., 2010. *Agile project management: creating innovative products.* Pearson Education; ISBN-13: 03216583959

Kong, S., 2007. *Agile software development methodology: effects on perceived software*, Google eBooks

Turner R., Boehm B., 2003. *Balancing agility and discipline: a guide for the perplexed* Addison-Wesley/Pearson Education; ISBN-10: 0321186125

Vinzi, V.E., Trinchera. L. and Amato. S, 2010. *Handbook of partial least squares.* Springer Berlin Heidelberg.

Periodicals

Abdulaziz I. A. and Mayhew, P., 2013. *An investigation of the critical success factors of IT projects in saudi arabian public organizations*, IBIMA Publishing.

Ambler, S., 2010. *Scaling agile: an executive guide,* IBM agility at scale.

Bagozzi, R. P., and Yi, Y., 1988. *On the evaluation of structural equation models. Journal of the Academy of Marketing Science.* 16 (1), pp. 74–94.

Bullen, C.V., Rokhart, J.F.,A, 1981. *Primer on critical success factors,* working paper no.69, Massachusetts institute of technology.

Charette, R., 2005. *Why software fails.* IEEE Spectrum.,pp. 42-49.

Chow, T., Cao, D., 2008. *A survey study on critical success factors of agile software,* Journal of Systems and Software

Doherty, M. 2012. *Examining project manager insights of agile and traditional success factors for information technology projects: a Q-Methodology study*, PhD, Marian University, Doctoral Dissertation.

Gorans, P., Kruchten, P., 2014. *A guide to critical success factors in agile delivery*, IBM center for the business of government.

Hair, J.F., Sarstedt, M., Ringle, C.M. and Mena, J.A., 2012. *An assessment of the use of partial least squares structural equation modeling in marketing research. Journal of the Academy of Marketing Science.* 40 (3), pp. 414-433.

Fornell, M.A., Lorcker, 1981. *Factor Analysis and Discriminant Validity: A Brief Review of Some Practical Issues* pp. 2-4

Larman, C., 2004. *Agile and iterative development: a manager's guide.* Addison-Wesley. p. 25.

Lee, L.; Petter, S.; Fayard, D.and Robinson, S., 2011. *On the use of partial least squares path modeling in accounting research.* International Journal of Accounting Information Systems12 pp. 305–328.

Lindvall M, Basili V, Boehm B. 2002. *Empirical findings in agile methods*, Volume 2418 of the series Lecture Notes in Computer Science, pp 197-207

Misra, S. C., Kumar, V., and Kumar, U., 2006. *Success factors of agile software development*, International Conference on Software Engineering Research and Practice, June, pp. 26-29

Nasir, M., Sahibuddin, S., 2011. *Critical success factors for software projects: a comparative study.* Scientific Research and Essays, pp. 2174-2186.

Nasir, M., 2011. *Addressing a critical success factor for software projects: a multi-round delphi study of TSP*, International Journal of the Physical Sciences Vol. 6(5), pp. 1213-1232.

Oferi, D., 2013. *Project management practices and critical success factors–a developing country perspective*, International Journal of Business & Management.

Peng, D.X.; Lai, F., 2012. *Using partial least squares in operations management research: a practical guideline and summary of past research*. Journal of Operations Management, pp. 467–480.

Sarstedt, M., Ringle, C.M., Smith, D., Reams, R., Hair, J.F., 2014. *Partial least squares structural equation modeling (PLS-SEM): a useful tool for family business researchers*. Journal of Family Business Strategy, pp. 105–115.

Schermelleh-Engel, Moosbrugger, K,H., and Müller, H., 2003. *Evaluating the fit of structural equation models: tests of significance and descriptive goodness-of-fit measures.* Psychological Research. 8 (2), pp. 23-74.

Wan, J. and Wang, R., 2010. *Empirical research on critical success factors of agile software process improvement*, Journal of Software Engineering and Applications, Vol. 3 No. 12, pp. 1131-1140.

Wan, J., Zhu, Y., Zeng, M., 2013. *Case study on critical success factors of running scrum*, Journal of Software Engineering and Applications.

Others

Campanelli, *A. S.*, 2016. *A Tailoring criteria model for agile practices adoption* http://www.fumec.br/revistas/sigc/article/view/3219 [accessed 12/03/2016]

Full Definition of AGILE: http://www.merriam-webster.com/dictionary/agile [accessed 01/05/2016]

Ken Schwaber, eWorkshop, 2002. *Summary of the First eWorkshop on Agile Methods.* [online] http://fcmd.umd.edu/projects/Agile/Summary/SummaryPF.htm. [accessed 08/05/2016]

Kwong, K., and Wong, K., 2013. *Partial least squares structural equation modeling (pls-sem) techniques using smartpls.* Marketing Bulletin. 24, Technical Note 1.

Mansor, Z., Yahya, S., Habibah, N., 2014. *Success determinants in agile software methodology,* [online] https://www.academia.edu/662661/Success_Determinants_in_Agile_Software_Development_Methodology. [accessed 12/04/2016]

Manifesto for agile software development: [online] www.agilemanifesto.org. [accessed 02/03/2016]

Mihmanlı, S., 2016, *Agile methodology and critical success factors (CSF) followed by a study case with fuzzy AHP*

Senapathi, M. and Srinivassan A. , 2014. *An empirical investigation of the factors affecting agile usage* [online] https://www.researchgate.net/publication/266658847_An_empirical_investigation_of_the_factors_affecting_agile_usage [accessed 02/02/2016]

The CHAOS Manifesto, 2015. Standish Group International. [online] http://www.infoq.com/articles/standish-chaos-2015 [accessed 03/04/2016].

APPENDICES

APPENDIX-1, CURRICULUM VITAE

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Education:

Primary School : Hanife Şefik Celep İlkokulu, 1991

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Undergraduate : Dokuz Eylül Uni. Computer Engineering Eng. , 2002

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Working Life :

NETAŞ, 2003 – cont

MSB Information Technologies,Izmir ; 2002 - 2003