

ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL

**DETERMINATION OF CRITICAL SUCCESS FACTORS IN AGILE PROJECT
MANAGEMENT WITHIN SOFTWARE DEVELOPMENT SECTOR: A META
ANALYSIS**



M.Sc. THESIS

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Department of Industrial Engineering

Engineering Management Programme

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İSTANBUL TEKNİK ÜNİVERSİTESİ ★ LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ

**YAZILIM GELİŞTİRME SEKTÖRÜ'NDE ÇEVİK PROJE YÖNETİMİ'NDEKİ
KRİTİK BAŞARI FAKTÖRLERİNİN BELİRLENMESİ: META ANALİZ**

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Dedicated to my beloved family,



FOREWORD

I present my endless thanks to my esteemed teacher, Assoc. Prof. Dr.Cemil CEYLAN who shared his experience with me and supported my thesis work.

I present thanks to my family; my mother Nergis ESKİ, my father Sulhi ESKİ, my sister Özge ESKİ and my fiancée Melisa ÜZELAKÇİL. They were always supporting me during the thesis work and lifelong.

December 2022

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ABBREVIATIONS

APM	: Approach Project Management
ASD	: Adaptive Software Development
CMA	: Comprehensive Meta-Analysis
CPM	: Critical Path Method
CSFs	: Critical Success Factors
DSDM	: Dynamic Systems Development Method
ES	: Effect Sizes
FDD	: Feature-Driven Development
IT	: Information Technology
ITU	: Istanbul Technical University
LD	: Lean Software Development
PERT	: Program Evaluation and Review Technique
PMBOK	: A Guide to the Project Management Body of Knowledge
PMI	: Project Management Institute
SAFe	: Scaled Agile Framework
UAT	: User Acceptance Test
XP	: eXtreme Programming
YÖK	: Higher Education Council



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DETERMINATION OF CRITICAL SUCCESS FACTORS IN AGILE PROJECT MANAGEMENT WITHIN SOFTWARE DEVELOPMENT SECTOR: A META ANALYSIS

SUMMARY

Meta-analysis is used as a method in this thesis, which aims to investigate and determine the critical success factors (CSFs) affecting agile project management success. Meta-analysis provides the opportunity to examine and interpret studies with a comprehensive and systematic perspective based on the findings. In order to achieve this, the researcher conducted a meta-analysis study on studies conducted in the field of software development's agile project management and determined CSFs that affect agile project management success. This process, which started with the literature review, continued with the development of the coding form after the determination of the study criteria to be included in the meta-analysis and the coding of the studies that fit the criteria in a way that could be included in the analysis. Afterward, data analysis was made and the obtained findings were evaluated.

In order to include studies that met the eligibility criteria in the analysis, the researcher reached the descriptive statistical information of each study in order to define the data. Due to the nature of the meta-analysis method, only studies containing quantitative data were included in this study, which aimed to systematically review experimental studies.

For this research, it is aimed to reach all studies that were made between 2005-2022 and suitable for the research problem. For this, Emerald, ProQuest, Elsevier, IEEEExplore, ScienceDirect, Springer and YÖK (Higher Education Council) National Thesis Center databases were scanned and Google Academic search engine was used. None of the study from Turkey was taken in meta-analysis because of the lack of matched study, but this study will be one of the pioneer study and shed light on Turkey.

In order to get insight into the quality of the studies included in the study, the reliability values of the studies were examined and seen that cronbach alpha reliability test results were appropriate in all studies which are gathered for meta-analysis.

In the course of analysis, Comprehensive Meta-Analysis (CMA) program was chosen to conduct meta-analysis. The included studies were merged using the meta-analysis technique. Directions and magnitudes of the effects were computed. According to the fixed-effects model, the total effect size of these investigations was calculated to be 0.634. Heterogeneity tests were conducted in CMA program.

Principal component analyzes were conducted to determine the critical success factors of agile project management success. In order to reach the findings related to publication bias in principal component analysis, the Funnel & Forest Plots were examined and interpreted in this way. As a consequence of these detailed tests, it was determined that publication bias did not exist. Moreover, 3,287 research which indicate CSFs negatively impact on agile project management success to be added to the existing sample in order to reject the conclusions from the 14 studies that

were part of the meta-analysis in the current study. To conduct this study, dependent variables (critical success factors) were analyzed and independent variable decided as agile project management success. In this study, 19 dependent variables are agile-oriented configuration management process, project team commitment, client consultation, commitment to agile methodology, communication, correct integration test mechanisms, customer collaboration, delivery strategy, team capability, planning and controlling, project mission, employee participation, organizational culture, team composition, sustainability, regular software delivery, shared leadership, team size and requirement change.

Meta-analysis results show the 19 relationships over 14 articles. Each correlation value of CSFs was taken from the CMA program.

There is strong relationship between shared leadership ($r = 0.630$), commitment to agile methodology ($r = 0.588$), team capability ($r = 0.577$), organizational culture ($r = 0.563$), team composition ($r = 0.552$), communication ($r = 0.543$), delivery strategy ($r = 0.533$), planning and controlling ($r = 0.532$), employee participation ($r = 0.526$), project team commitment ($r = 0.511$), project mission ($r = 0.501$), regular software delivery ($r = 0.441$), sustainability (0.415) and agile project management success.

There is a weak relationship between customer collaboration ($r = 0.357$), agile-oriented configuration management process ($r = 0.354$), correct integration test mechanism ($r = 0.316$), client consultation ($r = 0.307$), requirement change ($r = 0.300$), team size ($r = 0.255$) and agile project management success.

YAZILIM GELİŞTİRME SEKTÖRÜ'NDE ÇEVİK PROJE YÖNETİMİ'NDEKİ KRİTİK BAŞARI FAKTÖRLERİNİN BELİRLENMESİ: META ANALİZ

ÖZET

Günümüzde, değişen pazar dinamikleriyle birlikte ortaya çıkan yüksek rekabet ortamında işletmeler, müşterilerini analiz edebilme, beklentilerini anlayabilme ve ihtiyaçlarını karşılayabilme yetenekleri ile rekabette avantajlı hale gelmektedir. Değişen müşteri ihtiyaç ve beklentilerini sürekli takip etmek, değişen durumlara ayak uydurabilmek ve bu değişiklikleri nihai ürüne yansıtılabilmek giderek zorlaşmaktadır. Özellikle nihai ürünün müşterilerin talepleri ile şekillendiği proje bazlı çalışmaları gerçekleştiren işletmeler için işler daha da karmaşık hale gelmiş durumdadır.

Kısa teslim tarihleri, değişen öncelikler, yüksek paydaş katılımı ve esneklik ihtiyacıyla uğraşan işletmeler için proje yönetiminde “çevik yönetim” kavramı ön plana çıkmıştır.

İngilizce karşılığı “Agile” olan çevik kelimesinin kökeni yine İngilizce’deki “Agility” kelimesine dayanmaktadır. Agility kelimesi “değişen koşullara hızlı ve kolay cevap verme kabiliyeti” anlamına gelmektedir. Bu da proje yönetimindeki; esneklik, hızlı hareket kabiliyeti ve anında aksiyon alabilme ihtiyaçlarını karşılayabilmek adına önemli bir yaklaşım olduğunu göstermektedir.

Çevik yönetimin en önemli özelliği değişime uyum sağlayabilen bir yapıda olmasıdır. Ayrıca, insan iletişimine, geri bildirimine değer veren çalışma sonuçları üreten yinelemeli bir metodolojidir.

İnternetin hayatımıza bu kadar dâhil olmasıyla birlikte gelişen yazılım sektörü, kendi problemlerini proje yönetimindeki problemlerini çözmek için çevik yönetimi geliştirdi. Çevik proje yönetimi, işletmelere; projenin nihai ürüne ulaşma sürecinde sürekli yapılan kontroller, ihtiyaçları zamanında tanımlama ve detaylandırma, süreçleri ve projeyi sürekli iyileştirmek için geri bildirimler sayesinde yüksek kalitede proje çıktısı oluşturma imkanı sunar. Günümüzde, birçok işletme yüksek rekabet ortamında mücadele edebilmek ve rekabet avantajı sağlayabilmek amacıyla çevik proje yönetimini benimsemiştir. Diğer proje yöntemlerinde olduğu gibi çevik proje yönteminde de bazı kritik başarı faktörleri çevik proje yönetiminin başarısını etkilemektedir. Bu nedenle, çevik proje yönetiminin başarısını etkileyen kritik başarı faktörlerinin belirlenmesi şirketler açısından büyük önem taşımaktadır.

Çevik proje yönetimi başarısını etkileyen kritik başarı faktörlerini araştırmayı ve belirlemeyi amaçlayan bu tez çalışmasında, yöntem olarak meta-analiz kullanılmıştır.

Meta-analizi, belirli bir konuda yapılmış, birbirinden bağımsız, birden çok çalışmanın sonuçlarını birleştirme ve elde edilen araştırma bulgularının istatistiksel analizini yapma yöntemidir. Meta-analiz, bulgulara dayalı olarak çalışmaları kapsamlı ve sistematik bir bakış açısıyla inceleme ve yorumlama olanağı sağlar. Meta-analiz, ayrı çalışmaların bulgularının birleştirilmesi ve eleştirilerin yeniden gözden geçirilmesi yöntemidir. Meta-analizin özgüllüğü, tek başına yargıya güvenmekten ziyade nicel yöntemleri kullanmasıdır.

Çevik proje yönetimi başarısını etkileyen kritik başarı faktörlerini araştırmayı ve belirlemeyi amaçlayan bu tez çalışmasında, yazılım geliştirmenin çevik proje yönetimi alanında yapılan çalışmalar üzerinde meta-analiz çalışması yapmış ve çevik proje yönetimi başarısını etkileyen kritik başarı faktörlerini belirlemiştir. Literatür taraması ile başlayan bu süreç, meta-analize dahil edilecek çalışma kriterlerinin belirlenmesi ve kriterlere uyan çalışmaların analize dahil edilebilecek şekilde kodlanmasının ardından, kodlama formunun geliştirilmesi ile devam etmiştir. Daha sonra veri analizi yapılmış ve elde edilen bulgular değerlendirilmiştir.

Araştırmacı, uygunluk kriterlerini karşılayan çalışmaları analize dahil etmek için verileri tanımlamak amacıyla her çalışmanın tanımlayıcı istatistiksel bilgilerine ulaştı. Meta-analiz yönteminin doğası gereği, deneysel çalışmaları sistematik olarak incelemeyi amaçlayan bu çalışmaya, sadece nicel veriler içeren çalışmalar dahil edilmiştir.

Bu araştırma için 2005-2022 yılları arasında yapılmış ve araştırma problemine uygun tüm çalışmalara ulaşılması amaçlanmıştır. Bunun için Emerald, ProQuest, Elsevier, IEEEExplore, ScienceDirect, Springer ve YÖK (Yükseköğretim Kurulu) Ulusal Tez Merkezi veritabanları taranmış ve Google Akademik arama motoru kullanılmıştır.

Bu çalışmaya dahil edilen geçmiş çalışmaların kalitesi hakkında fikir sahibi olabilmek için çalışmaların güvenilirlik değerleri incelenmiştir. Meta-analiz için toplanan tüm araştırmalarda, cronbach alfa güvenilirlik testi sonuçlarının uygun olduğu görülmüştür.

Analiz yapılırken uygulama olarak CMA (Comprehensive Meta-Analysis) programı kullanılmıştır. Bu çalışmaya dahil edilen geçmiş çalışmalar, meta-analiz tekniği kullanılarak birleştirildi. Etkilerin yönleri ve büyüklükleri hesaplandı. Sabit etkiler modeline göre bu araştırmaların toplam etki büyüklüğü 0.634 olarak hesaplanmıştır. CMA uygulamasında, heterojenlik testleri yapılmıştır.

Çevik proje yönetimi başarısının kritik başarı faktörlerini belirlemek için temel bileşen analizleri yapılmıştır. Temel bileşen analizinde, yayın yanlılığı ile ilgili bulgulara ulaşmak için Huni ve Orman Grafikleri incelenmiş ve grafikler üzerinden yorumlarda bulunulmuştur. Bu detaylı testler sonucunda, yayın yanlılığının olmadığı belirlendi.

Ayrıca, bu çalışmada meta-analize dahil edilen 14 çalışmadan elde edilen sonuçları geçersiz kılmak için kritik başarı faktörlerinin çevik proje yönetimi başarısını olumsuz etkilediğini gösteren 3.287 çalışmanın, mevcut örnekleme eklenmesi gerekmektedir.

Bu çalışmayı yürütebilmek için bağımlı değişkenler (kritik başarı faktörleri) analiz edildi. Bağımsız değişken, çevik proje yönetimi başarısı olarak belirlendi. Bu çalışmada 19 bağımlı değişken, çevik odaklı yapılandırma yönetimi süreci, proje ekibi bağlılığı, müşteri danışmanlığı, çevik metodolojiye bağlılık, iletişim, doğru entegrasyon test mekanizmaları, müşteri işbirliği, teslimat stratejisi, ekip yeteneği, planlama ve kontrol, proje misyonu, çalışan katılımı, organizasyon kültürü, ekip kompozisyonu, sürdürülebilirlik, düzenli yazılım teslimi, paylaşılan liderlik, ekip büyüklüğü ve gereksinim değişikliğidir.

Meta-analiz sonuçları, 14 makale üzerinden 19 ilişkiyi göstermektedir. Her bir başarı faktörünün korelasyon değeri, CMA programında hesaplanmıştır.

Paylaşılan liderlik ($r = 0.630$), çevik metodolojiye bağlılık ($r = 0.588$), takım yeteneği ($r = 0.577$), organizasyon kültürü ($r = 0.563$), takım kompozisyonu ($r = 0.552$), iletişim ($r = 0.543$), teslim stratejisi ($r = 0.533$), planlama ve kontrol ($r = 0.532$), çalışan katılımı ($r = 0.526$), proje ekibi bağlılığı ($r = 0.511$), proje misyonu ($r = 0.501$), düzenli yazılım

teslimi ($r = 0.441$), sürdürülebilirlik (0.415) ve çevik proje yönetimi başarısı arasında güçlü bir ilişki vardır.

Müşteri işbirliği ($r = 0.357$), çevik odaklı yapılandırma yönetimi süreci ($r = 0.354$), doğru entegrasyon test mekanizması ($r = 0.316$), müşteri danışmanlığı ($r = 0.307$), gereksinim değişikliği ($r = 0.300$), ekip büyüklüğü ($r = 0.255$) ve çevik proje yönetimi başarısı arasında zayıf bir ilişki vardır.





1. INTRODUCTION

“Project” or “project management” terms can be heard in people’s current life. Each organization, company, people are using these terms to address process of progressing or done works. Even in daily talks, these terms are being used.

It is crucial to comprehend project term to discuss project management. According to Project Management Institute (PMI), to produce an original product, service, or outcome, a project is started (PMI, 2008). To produce an original product, service, or outcome, a project is started.

Projects are emerged by a person, institutions and organizations requirements or consequences of scientific and technological advances. From the beginning of 20th century, business organizations started to be more interested in new management approaches to increase the level of institutionalism and competitive advantages and to decrease costs by using resources in optimum. Project is an activity which initially has determined requirements for defined purposes, last delivery date, results, risks, sources and organization structure (PMI, 2008).

In the challenging business environment, organizations try to achieve maximum efficient of projects and evaluate the risk factors for projects. Within the scope of ever-growing technology, project managers are compelled by limited resources and rapid changes in business. Hence, project management becomes to take an important role for organizations. In addition, top management of organizations take account of project management methods.

Nowadays, many companies and people give importance to management of project. In former times, project management concentrated on providing schedule and source data to upper executives in particular sectors. At the present, project management includes much more than as it used in the past and people from each industry manages projects (Yeşilyurt, 2022).

Project management methodology effects project success. A project success directly effects an organization's success. Thus, project management methods should be fit to project structure and examined in detail.

Adoption of different project management methods for different industries could be more effective on project success. While managing software development projects with agile methods could give best level of success, managing marketing projects with traditional methods could be more appropriate rather than using agile methods.

As organizations gain experiences in project management, they begin to adopt modern project management rather than traditional project management. As a result of modern project management adoption, methods such as agile project management were revealed.

An approach project management (APM) called "agile" to serve high level innovation and added value to customer, and achieve higher performance by less executive effort within the scope of cost, time and quality. The APM strategy seeks to simplify, adapt, and automate the process of project management (Conforto et al, 2014).

According to the detailed literature review, it can be seen that a project success can be evaluated by project's critical success factors (CSFs). Up to the present, many researches about project's CSFs were conducted. These researches contributed to this work and helped author to comprehend terms.

Rockart (1979) emphasizes CSFs in which aims to reveal organizational critical points especially related with management. CSFs enhance organizational development, ease to achieve organizational purpose and specify the factors which prevents to be successful.

Within the scope of this work, agile project management critical success factors were researched during the literature review. Previous researches gathered, eliminated and prepared for meta analysis to identify agile project management CSFs.

1.1 Purpose of Thesis

In this study, it is aimed to determine critical success factors which affect agile project management success by meta-analysing. Figure 1.1 illustrates research model.

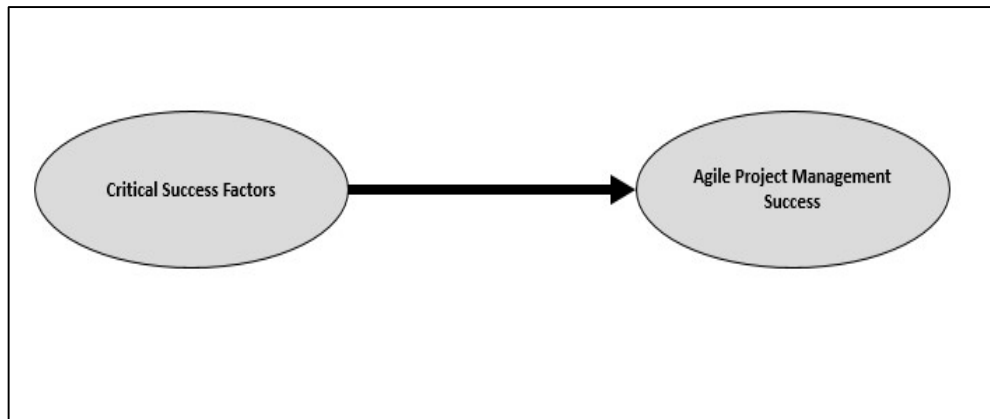


Figure 1.1 : Research model.

In this study's second chapter after introduction, project term, project management term, project life cycle and waterfall project management methodology are explained according to literature review.

In the third chapter, agile term, agile project management and agile methods are given in detail; in the fourth chapter, project success concept and critical success factors term are explained. Meta-analysis method and its phased are given in detail in the fifth chapter.

In the sixth chapter, research methodology of this study is explained. Research process is divided into steps. Each steps are given in detail. Meta-analyses results are shared and discussed.

In the last part of this master thesis, conclusion of this study is completed and explained in detail. In addition to conclusion part, recommendations for future are given briefly.



2. PROJECT MANAGEMENT APPROACHES

2.1 What is Project?

The term of project has various definitions. According to Project Management Institute (PMI), to produce an original product, service, or outcome, a project is started. (PMI, 2008). In another definition, project is a series of activities which has clearly defined start-end points, purpose, scope and budget (Note, 2015).

Atkinson (1999) defined that, a project is a human operations that attains a clear purpose towards a time scale.

Projects have specific features listed below:

- Projects are unique.
- Projects are temporary by nature and have start-end dates.
- Projects are completed when achieved to purposes or defined that project is no longer applicable.

Projects are emerged by result of change requirements and being executed to bring innovation (product development, process improvement, new quality standards definition etc.). Projects is a process from idea to implementation phase and a good project has several features:

- Project is started and completed according to defined program.
- Project's scope is defined and not changed significantly in a time.,
- Project's resources are determined and remains similar in the course of project.
- Project's budget can be spent as required and should not be exceeded.
- Each project's role is clearly defined and all partners stick to their roles.
- Project's risks are identified and project is managed by taking into consideration of these risks.
- Project's human resources, process and quality of contents are under control.

- All project's partners are aware of project's target and purpose. Target definition is the first stage of project. Proper target determination could be quite difficult, but target definition and success factors identification extremely important.

Each project's purpose is to achieve target within the scope of budget and time restrictions by optimizing sources. A successful project meets defined targets, but project management considers not only to achieved aimed conclusion but also efficient work and staying in project's budget (Yeşilyurt, 2022).

2.2 What is Project Management?

Project management emerged at the end of the 19th century with management ideas that were shaped and developed with the increasing complexity of corporate life. Especially large-scale government projects carried out in those years contributed to the emergence of project management.

In the early 1900s, Frederick Taylor discovered that management techniques could be analyzed and developed scientifically. Taylor made business processes' simple parts more efficient by analyzing these parts one by one (Yüksel, 2003, p. 83).

In 1917, Henry Gantt developed Gantt diagrams which provides great convenience in the creation of the project calendar. Gantt diagrams contributed to following fields; project planning, project monitoring and performance measurement (Kolaylıoğlu, 2006).

The concept of project management became popular in the defense and armaments industries in the 1930s and 1940s. However, the Manhattan Project is generally considered to be the place where project management was born. In 1958, Program Evaluation and Review Technique (PERT) diagrams were used for the first time in the project of the construction of Polaris submarine missiles in the American army. In the 1970s, project management tools was developed by software companies such as Oracle. Critical Path Method (CPM) helped project manager to increase control over project flows. These techniques were first used in armaments industry to develop weapons, then began to used for industrial projects in competitive environment.

In 2001, Agile Manifesto which aims to to ensure high performance of software development teams was written.

In 1969, Project Management Institute (PMI) was established by volunteers with the purpose of defining project management standards and supporting best practices. Today, PMI has 475,000 members in 207 countries. In the same year with establishment, PMI published PMBOK.

PMI (2008), defines project management as the execution of workflows, methods, information and capabilities to get the target of the project. PMI made some changes in PMBOK 6 (2017) edition within the scope of increased Agile approaches use in the sector.

Project management concept includes planning, organization, coordination and controlling activities to ensure to achieve aims according to the defined project's schedule. Another function of project management is that to define project requirements, scope, sourcing, planning, controlling and monitoring.

Each project has restrictions; budget, time, etc. There are some restrictions and risks to be considered to achieve ultimate project success. Restrictions in project and project management affect each other. At the same time, restrictions in project management define limits in project (PMI, 2017).

Timing is an important tool to manage projects; but defining a common concept to project success and defining works to be done is more important. More effort and source are consumed to lessen time of project; but this causes an increase in project costs. Project scope defines required work to provide service or product which are aimed before. Besides, product scope defines product's feature, functionalities and intended quality (Chatfield and Johnson, 2007). In similar, increase in scope causes an increase in cost and project duration. Because of direct interaction between restrictions, restrictions for project should be considered together rather than considering partially.

Project manager is the person who ensures the fulfillment of the project objectives. Project manager improves effective communication between project stakeholders and project team members; manages project resources, prepares process documentation by using project management tools, defines project scope and tells team members. Project managers should proactively act about dynamic environments changes and complexity. This means that project managers could realize potential risks, transfer risks to related units and take precautions.

2.3 Project Life Cycle

Project management is a management of a set of organized activities for common purpose by using specific management structures and techniques. Projects generally goes through the same stages from start to finish. Project management function can be carried out by initiating, planning, executing, controlling and closing processes. These processes are defined as main project processes. Figure 2.1 shows the project life cycle (PMI, 2000).

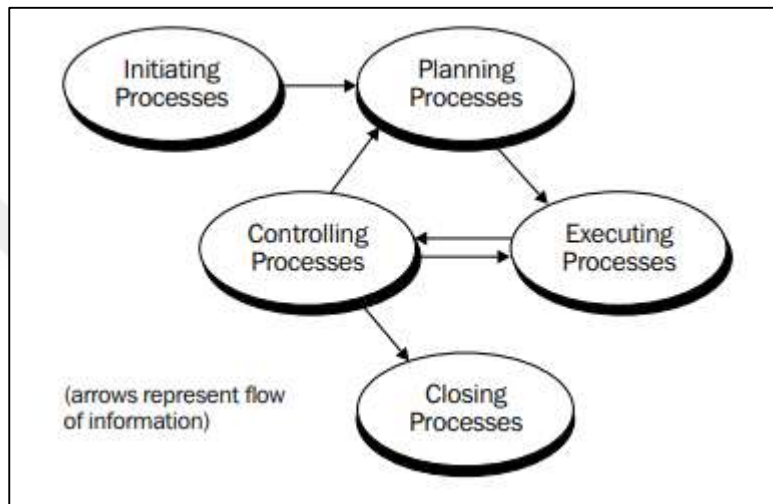


Figure 2.1 : Project life cycle.

Initiating: A project's first stage in project life cycle called as initiating. This stage includes;

- project definitions,
- financial sources determination,
- project realization decision,
- project team creation and
- job descriptions definitions.

Project targets, restrictions and risks are determined with project stakeholders. Project feasibility process could be performed depend on project type. Project requirements are gathered and analyzed in information technology (IT) projects.

Planning: Planning is the second stage in which detailed plannings are made about project. This stage includes;

- determination of activities that creates project and interactions among them,
- project activities' time, source and cost analyzes.

Planning is the most important stage in Project Life Cycle; because project activities steps, responsible project members and project duration determination is conducted in this stage. Project manager should assign correct person to project and define project activities/scheduling in planning stage.

Executing: Executing is the third stage in Project Life Cycle. Main purpose of this stage is that execute planned activities to achieve targets within the framework of time and sources. Project is being started to implementation as planned before. Project activities are completed by project members or units within time and source restrictions.

Controlling: In this fourth stage, data is gathered which is related with defined indicators and compared with plans to get information about project progress. When plan does not meet with project data or not following right way, required decisions and precautions are taken to fix this situation. If no action could be taken to fix controlled plan, plan is changed and approved then create base of project progress monitoring. All these actions do not means that project is failed. Controlling in this stage, managing changes and rescheduling are the most difficult duties for project manager.

Closing: Project closing indicates that project is officially completed. At this point, project is completed by terminating project organization, submitting project outcomes to ultimate stakeholders and withdrawing assigned sources. Besides project outcomes, analysis report are prepared and delivered for project documentation and evaluation (PMI, 2008).

These five stages are progressed linearly. Without completion of any step, another step cannot be started. In traditional project management, Waterfall methodology are used frequently, next chapter explains waterfall project management methodology.

2.4 Waterfall Project Management Methodology

The waterfall methodology is the earliest and most fundamental type of software engineering, and it calls for the gradual implementation of project-related tasks.

Nowadays, authorities and major corporations adopt it as the management standard for all project types (Munassar and Govardhan, 2010).

Software Engineering Conference organized in Germany in 1968 by the NATO Scientific Committee because of software crisis experienced in the 1960s due to the facts that software projects grew over time and required a project management methodology, there will be no tolerance for errors in critical systems any more, fast increase of computer storages with the development of technology.

Main topics discussed at this conference are the definition of engineering of software and determination of standards that should be implemented in development of software steps (NATO Science Committee, 1968).

A short time later, in 1970, Dr. Winston Royce described the Waterfall Model in a published manifesto (Royce, 1970).

Although Dr.Royse mentioned the successive stages, customer collaboration in software development process proposed in methodology that will be named as “agile” after 30 years, the waterfall method took the form that known today and became the basis of software development methodologies in time. Figure 2.2 shows the stages of waterfall (Palmquist et al, 2013).

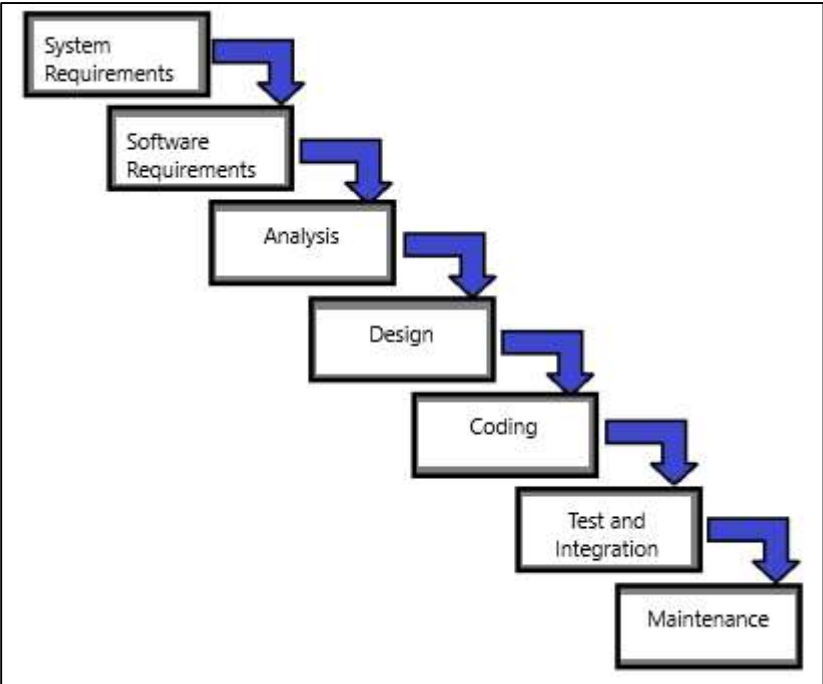


Figure 2.2 : Waterfall model stages.

At conclusion of every step, paperwork is collected as an outcome, and every outcome serves as the input for the step that follows. Jumping between stages or large-scale roll-back is not allowed, as the possible changes that will occur cost the project a lot because of the output-input relationship. Phase finishings are obviously described in waterfall projects and the project is carried out under an intensive supervision with controls such as strict examinations, intensive documentation and management approval at every stage change. Therefore, its implementation requires strict discipline. This model adopts the philosophy of “grand design from the front” and a considerable analysis and design is completed before the coding phase (Farrell, 2007).

System and software requirements are determined at the very beginning by accepting the assumptions that everything necessary is known from the beginning and there will be no changes (Palmquist et al, 2013). Thus, it is more suitable for well understood projects that do not contain uncertainty and are unlikely to change (Sommerville, 2011). Because, these assumptions constitute the biggest weakness of the waterfall model.

Waterfall model focuses mostly planning, timelines, target dates, budget and one time use of the entire system issues. The main purposes of this approach are to disable change factor which is a big risk factor, and state scope, time and resources factors by not allowing to changes in the course of a project (Vohra and Singh, 2013).

Waterfall methodology involves the linear work of team members for a specific finish target. Every individual's responsibility is well-defined, and neither the stages nor the objectives are supposed to alter. The methodology has the potential to work well for projects that require a single timeline, and has detailed plans. Roll-backs for change, development or correction liken to swimming against flow in waterfall and are hard and costly. Therefore, it cannot respond to changes and requests received during the process are mostly not accepted.

Therefore, the waterfall methodology is less effective for knowledge-based and change-oriented projects such as software. The agile project method is needed at this point (Awad, 2005). In the next section, agile and agile project management is described.



3. AGILE PROJECT MANAGEMENT

3.1 What is Agile?

By alone, the term "agile" denotes something that is adaptable and quick to change. Therefore, Agile approaches indicates that they have the "[capability] to endure in environment of continual changes and arise with achievement" (Anderson, 2004).

Since " software delivery has become rivalry of software more than before" and " along with releasing software and minimizing bugs, a company requires monitoring constantly shifting customer and market demands", this "maneuver-ability" in the business of software is a quality which became more crucial than before (Cockburn, 2002).

17 renowned software specialist, in 2001, came together to promote a more effective method of generating software created the Agile Alliance and adopted the official definition of Agile Software Development in a form of "manifesto". The following is directly taken from the "Agile Software Development Manifesto" (Url-1).

“We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to 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” (Url-1).

Even though the goods on the right have worth, we place a higher value on the items on the left (Aguanno, 2004).

Particular practices and tools, documentation, arguing the project's scope, and creating and adhering to a plan are required for some projects. Agile principles place a strong emphasis on integrating the project demands that are unique to the project and synchronizing with the business requirements of the sponsor, building the proper

functionality, minimizing resource waste by removing redundant features, and creating business value (Syeda, 2018).

The following 12 principles were prioritized by the Agile Alliance (Beck et al, 2001):

- “Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
- Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
- Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
- Business people and developers must work together daily throughout the project.
- Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
- The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- Working software is the primary measure of progress.
- Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
- Continuous attention to technical excellence and good design enhances agility.
- Simplicity - the art of maximizing the amount of work not done - is essential.
- The best architectures, requirements, and designs emerge from self-organizing teams.
- At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.”

The Agile Alliance placed a strong emphasis on strong cooperation between the software team and business professionals via face-to-face dialog as a more effective than written formal documentation; frequent release of new deployable business value; strict teams for example; integration, testing and continuous planning so that the undesired needs was prevented from evolving into a problem (Syeda, 2018).

3.2 What is Agile Project Management?

Conforto et al. (2014) defines agile project management as an approach to provide an innovation and added value to the customer at a higher level with less administrative effort and higher performance (in terms of quality, cost and time) which targets simplify management of project process and iterative.

Augustine et al. (2005) states that the following applications are necessary for adaptive agile project management:

- An ability to manage change and adaptation
- Considering organizations as changeable and adaptable systems which are consisting of intelligent people
- Being aware of the limits of external control in organize
- A general humanistic problem-solving approach that should rely on teams for problem solution tool; considering all its members as capable and valuable stakeholders in team management, and emphasizing adaptability to changing conditions instead of pre-planning.

An agile organization should be created to strengthen and manage agile project management. This agile organization communicates between external partners and team members during agile project management and it is really the biggest challenge to effectively carry out agile practices in a company (Sharifi et al, 2001).

Agile production can be characterized as the capacity to develop customer-designed products and services, to survive and develop by reacting quickly and successfully to changing conditions in a competitive environment where constant and unpredictable changes are experienced (Cho et al, 1996).

To make it compatible with agile production, it is important to provide a tool that supports each project developed by the company. Therefore, it is necessary to implement agile project management (Loiro et al, 2019). Agile project management is carried out through agile teams. It follows certain routines and a sequence of activities.

Each feature is analyzed, designed, developed, and tested by the Agile team throughout a number of iterations.

Each team performs a daily stand-up meeting throughout the course of a normal workday and all team members report their work which have performed up to time; what they will handle on close future; and mentions any challenges or obstacles given tasks. Visual representations of process and setbacks are shown to keep everyone informed about progress and obstacles. To address any problems or obstacles, extra sessions are organized. No new needs are created, but the ones that already exist might be clarified during each stage.

A functional piece of software or functionality is provided to the client at the completion of each stage. The capability is either deployed or carried on for further improvement in following step which is depending on the level of client satisfaction. The necessary forms are finished at this time. Incomplete capabilities are added to the backlog, and reprioritization may be required if priorities have changed.

Deliveries and stages proceed till the customer has received all requested capabilities, or all allocated funds have been used, or the deadline has passed. Figure 3.1 shows an example of a typical agile development cycle (Syeda, 2018).

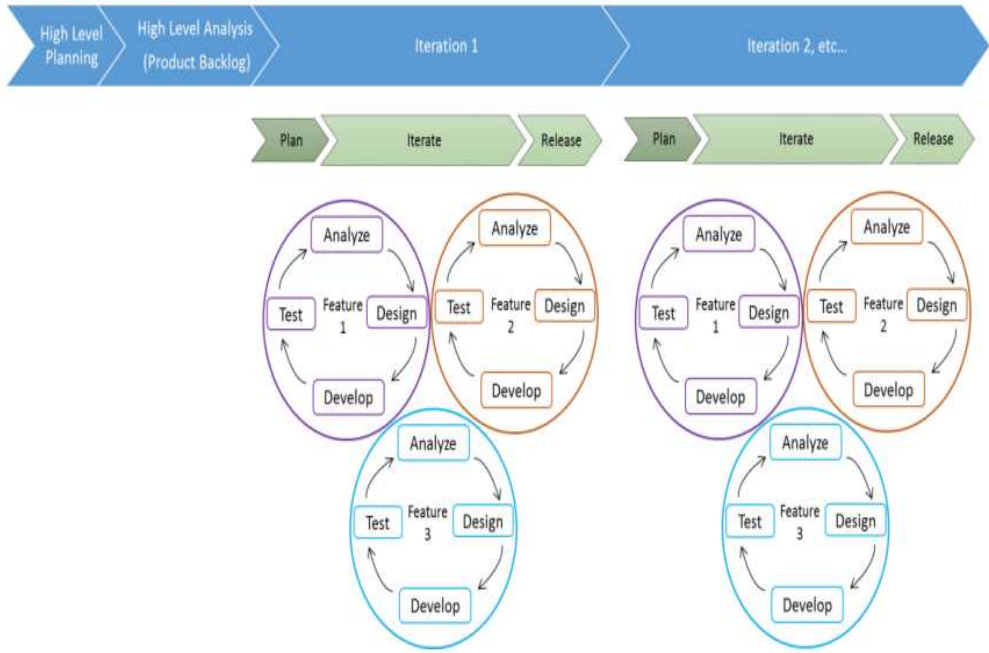


Figure 3.1 : Agile development cycle.

Agile project management explains that being involved in planning and control of the project contributes to improving the communication and interaction between the people in team (Boehm and Turner, 2005; Augustine, 2005; Highsmith, 2004).

Conforto et al. (2014) stated that project management of agile approach could also be applied to more traditional industry sectors other than the software sector.

3.3 Agile Methods

The needs, design, test and release, and major purpose are both same in the traditional and agile methods. But, “how” to deliver? question differs strongly between traditional and agile methods. The same programming structure elements of scope, budget, plan and performance also place limitations on both methods (Palmquist et al, 2013).

In the most general sense, traditional methods freeze the needs in beginning of the development process and then permit cost, planning, and performance to change. By contrast with traditional method, cost, planning, and performance defined in beginning and the needs could change (Palmquist et al, 2013).

Agile methods are created by short-quick times delivery that are in harmony with the management of unpredictability and changing needs. They are naturally responsive to a changing situation (Sheffield and Lemétayer, 2013).

Major planning in the traditional methods is done via taking into consideration of cost, plan and deliverables. Via empowering the team members, agile substitutes the one-time scheduling with an incremental and adaptive succession of just-in-time tasks. Thus, agile could give adaptability and flexibility (Sheffield and Lemétayer, 2013).

The traditional methods are more appropriate for ensuring predictability, stability, and high-assurance in the development projects, whereas agile approaches are more focusing on customer satisfaction, and offering faster solutions to changing needs with quick release period (Misra et al, 2012).

There are various particular agile development methods that are living. Several agile methods already existed before the Agile Manifesto published. Elements of these methods are particularly similar that deal with agility, change management, scheduling, interactions, and ongoing learning.

In Table 3.1, some major differences between waterfall project management and agile project management are listed. Comparison list is summarized from second and third chapters.

Table 3.1 : Comparison between waterfall and agile project management.

Waterfall Project Management	Agile Project Management
Suitable for well understood projects	Suitable for all kinds of projects
Does not contain uncertainty	Might contain uncertainty
Unlikely to change	Likely to change
Requires a single timeline	Might have more than single timeline
Roll-backs for change is costly	Roll-backs for change is costless
Cannot respond to changes and requests	Can respond to changes and requests
Less effective for knowledge-based and change-oriented projects such as software	More effective for knowledge-based and change-oriented projects such as software
Created by long times delivery	Created by short-quick times delivery

This goal of section is to give readers an understanding of the current, widely used agile methodologies which became popular after Agile Manifesto. In project management, there are several agile methods to be used for different businesses and company culture; Scrum, eXtreme Programming (XP), Kanban, Feature-Driven Development (FDD), Adaptive Software Development (ASD), Crystal methodologies, Lean Software Development (LD), Dynamic Systems Development Method (DSDM) and Scaled Agile Framework (SAFe). These methods will be briefly described below.

3.3.1 eXtreme Programming (XP)

Computer programming using the XP methodology emphasizes interaction, simplification, accountability, and boldness (Palmquist et al, 2013). It focuses on enabling software developers to adapt to shifting client requirements late in the life cycle and is intended for tasks with highly dynamic needs (Dybå and Dingsøy, 2008). Guiding principles for computer programming are the main subject.

There are twelve principles within that approach (Cohen et al, 2004):

- Concept of organizing
- Micro deliveries
- Symbolism
- Basic design and testing
- Versioning
- Coding in couples
- Participation

- Constant insertion
- Forty hours duration in a week
- On-desk clients
- Programming guidelines

3.3.2 Scrum

When preparing in advance cannot be a feasible, Scrum focuses on project management. At the 1995 ObjectOriented Programming, Systems, Languages & Applications (OOPSLA) workshop, Schwaber delivered a work that contained a definition of it. Scrum is "an improvement of the iterative and incremental approach to developing element software," according to Schwaber. Scrum comprises three main stages as well as several smaller stages. Pregame, game, and postgame are these stages (Schwaber, 1995). Strategy and design are the pregame substages. While the design stage comprises architectural information, including changes to the system design, the strategy phase includes the determination of release substance, expense, and timeline. To generate functional software, one or more programming sprints are carried out during the game phase (Mueller, 2014). The application is verified, the paperwork is finished, and the launch is ready to be sent to the client during the postgame substage of completion (Mueller, 2014).

The prerequisites for this collaborative method are continually shifting. In order to provide successful outcome in brief and periodic sprints, Scrum places a strong emphasis on continuous feedback loops and gradual modifications. A backlog is recorded for enhancements that need to be deployed inside the program. The next step is for the product owner to select what issue from the backlog will be created during the subsequent sprint. There are daily stand-up sessions when teammates plan efforts. The squad's scrum master is in charge of handling issues that prevent the squad from functioning efficiently (Dybå and Dingsøy, 2008).

Scrum techniques work well for small and mid-sized businesses. Organizations using Scrum teams incur the threat of scope creep and necessitate a substantial amount of dedication and skill. Figure 3.2 shows the Scrum methodology's progress (Boehm and Turner, 2009).

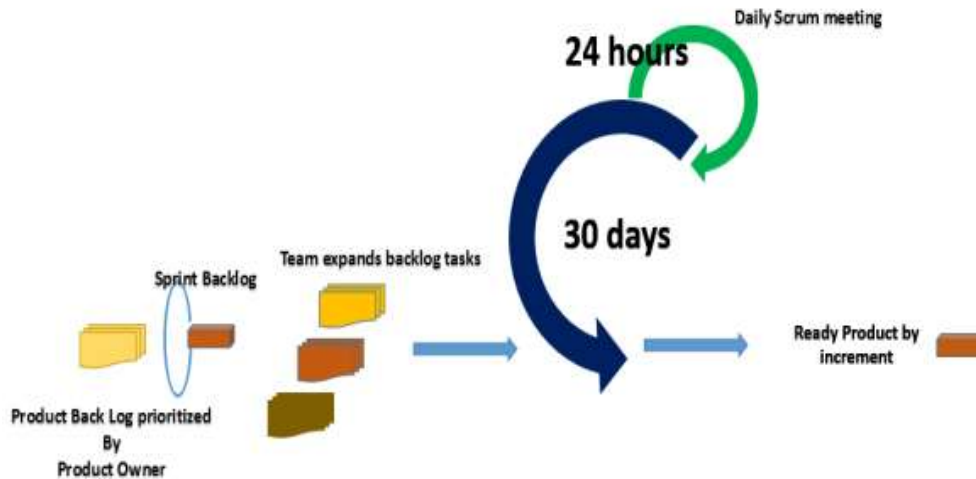


Figure 3.2 : Scrum methodology's progress.

3.3.3 Kanban

Kanban targets gradual, progressive transformation by continually improving current procedures. Self-organizing, enhanced squads prioritize reducing unnecessary procedures and other tasks. A Kanban board is a tool used in this strategy to carry out the procedure. This board may be a tangible one to depict progress of the project and objects graphically, or it may be an application that imitates a real Kanban board. This panel is made up of different columns that serve to keep record of the chores that need to be completed, the jobs that have already been done, and the jobs that have been finished. Backlog, readiness, programming, reviewing, acceptance, and completed columns could be present in a programming project's divisions (Url-2).

3.3.4 Feature-Driven Development (FDD)

The emphasis is on creating useful outputs every 2 weeks, enabling examinations, lowering threats through regular release of usable functional outcomes, and providing a thorough planning and measuring guide (Dybå and Dingsøy, 2008). The 5 steps that make up FDD are: (1) developing a framework; (2) making a list of features that should be emphasized; (3) planning progress by characteristic; (4) constructing the program by characteristic; and (5) developing the characteristic processes inside FDD (Meso and Jain, 2006). According to this strategy, each characteristic is designed and created separately over a certain period of time in order to provide outcomes and guarantee quality (Mueller, 2014).

3.3.5 Adaptive Software Development (ASD)

Jim Highsmith and Sam Bayer created this strategy. It is founded on the ideas that constant adjustment of a processes designed to cope with transformation is the standard (Boehm and Turner, 2009). This approach emphasizes conduct of activities while combining the model-driven and agile development approaches (Meso and Jain, 2006). ASD substitutes a recurrent set of hypothesize, cooperate, and learn phases for the waterfall loop (Boehm and Turner, 2009). Instead of emphasizing the refinement of program management approaches, it focuses on the creation of high-quality products resulting from quick adaptability to both external and internal events (Meso and Jain, 2006).

3.3.6 Crystal methodologies

Alistair Cockburn invented this technique. It presents a set of associated techniques that handle how the project life cycle and particular project characteristics evolve during the project's life cycle (Boehm and Turner, 2009). The hue that indicates the quantity of the engineering team and the "rigidity" that indicates the importance of the work are two of the numerous versions of this system (Boehm and Turner, 2009). It is mostly appropriate to computer programming for non-life-critical initiatives in workgroups that may communicate often.

3.3.7 Dynamic Systems Development Method (DSDM)

The approach was initially presented in 1994 and is still changing today. Evaluation, Management Research, Programmable Refinements, Layout and Constructed Incremental Development, and Deployment are the five stages of the DSDM approach. Significant focus is placed on the management of projects throughout the conceptual and commercial research stages, whose outcomes feed the subsequent sequential and iterative stages. Each step entails preparatory work, and scheduling is the main tool to monitor, regulating, and planning (Boehm and Turner, 2009).

3.3.8 Lean Development (LD)

Bob Charette created the approach. It developed from issues connected with kaizen and financial planning. One of the main ideas behind this approach is "threat" in which one looks for situations that might turn danger to possibility (Boehm and Turner, 2009). Initiation, continuity equation, and switchover are the three stages of this cycle.

Anyone in the corporate structure who is engaged in is active (Boehm and Turner, 2009).

3.3.9 Scaled Agile Framework (SAFe)

In order to create thorough skill set for adopting agile systems thought companyt level, SAFe makes use of the principles of agile methods. SAFe's popularity stems from its capacity to provide value consistently, effectively, and on time. Since its launch in 2011, SAFe has grown in recognition. The concept makes it feasible to quickly adapt the ideas of Agile and Lean methods to the requirements of major information and technology organizations. Agile method, organizational theory, and minimal program management are its 3 major basements of it (Url-3).



4. PROJECT SUCCESS

It may seem straightforward to decide whether a project will succeed, yet this is still a hotly contested topic (Shrnhur et al, 1997). Several academics also raise the potential that due to poor scheduling, administration, and methodology, success of a project could not be known (Al-Ahmad et al, 2009). Managers must develop clear and consistent performance goals as well as the metrics used to gauge performance (Watson, 2009).

Duration, money, and the program's final result are straightforward measures of it (Ika, 2009). However, scholars claim that these criteria represent a barrier to determining project success and the factors related to success. Rosenau (1984) goes so far as to identify these three criteria as the triple constraint. Likewise, Sommer (2004) emphasized the expansion of success criteria with identifying different factors.

Shrnhur et al. (1997) developed a multidimensional model for project success using contingent organizational theory. Other scholars have credited this model as “the most important line of research” (Ika, 2009, p. 113) in determining project success.

The Standish Group (2011) reported that agile projects are successful three times more often than nonagile projects. The report indicated, “The agile process is the universal remedy for software development project failure. Software applications using agile process have three times the success rate of the waterfall method and a much lower percentage of time and cost overruns” (p. 25). The Standish Group defined project success as on time, on budget, and with all planned features (requirements) implemented. The outcomes come from initiatives carried out between 2002 and 2010.

4.1 Critical Success Factors

Critical success factors (CSFs) are frequently used as assessment techniques (Nixon et al, 2012). By comprehending the associated CSFs, a project's many institutional and psychological issues may be handled. A number of lists of factors have been published since the 1960s, during which time certain studies have concentrated on particular

issue categories and action kinds while others have proposed CSFs that can be utilized for all types of initiatives (Fortune and White, 2006).

Identification of critical success factors can allow project managers to avoid faulty assumptions about software development (Cottmeyer, 2009). Accurate identification of critical success factors, and their implementation, can also increase certainty and improve market timing, which has become increasingly difficult now that project life cycles are much shorter than previous eras. Agile critical factors are particularly necessary to identify because they relate to the ever-changing nature of projects.

Cottmeyer (2009) created a set of fundamental principles for managing agile projects that are specific to their accomplishment. The fundamental principles involve;

- Self-organization that involves both squad and manager. Both parties must be responsible for delivery and requires them to be self-organized since direct supervision is not always possible or even desirable.
- Empowerment related closely to self-organization. This is the result of the environment that is established by the project manager.
- To enable the highest efficiency from colleagues, trustworthiness is necessary. Trust given to worthy subordinates elevates their aspirations, and with it a feeling of respect comes responsibility. Trustworthiness also facilitates a healthy team culture of goodwill and positive interaction.
- In return for the autonomy that is given to agile project team members under this framework, accountability is necessary. This translates into frequent delivery on deadline during the process.

Sliger and Broderick (2008) described critical success factors to increase vend to third parties:

- Face-to-face meetings
- Gross-level estimating or estimates based on general guidelines more than fixed estimates
- Technical planning emerging from self-organizing teams (Real versus unrealistic feature sets)
- Long-term budgeting.

Critical success factors can also be conceptualized as what is necessary to meet the desired deliverables of the project (Kerzner, 2009). From this perspective, critical success factors are those that meet the minimum requirements for the project, not the optimal provision of deliverables from an efficiency and business value perspective. In order to diminish confusion between minimum and optimal critical success factors, Kerzner recommended distinguishing these as primary and secondary, respectively.





5. DEFINITION OF META-ANALYSIS

Meta-analysis could be described as a statistical interpretation of quantitative data belonging to groups after gathering the findings of a variety of relevant research using specified criteria, making it feasible to get studies on similar concerns or themes within an area of study. The researcher is likely to construct plausible explanations regarding the study area using the data acquired. Since these plausible explanations are premised on statistical data, they provide a scientifically supported conclusion to the researcher. Thus, all studies included in the study can be interpreted as if they were a single study. In this respect, the scope of the term "meta-analysis" is wide, because meta-analysis not only allows for a general conclusion to be reached by integrating the results, but it also allows for the results of a study to be analyzed again. Karl Pearson's research in 1904 to explore the link between vaccination and typhoid illness was the first meta-analysis study identified in the worldwide literature. With this respect meta-analysis was initially employed in health-related scientific research. Its application in the social sciences dates from the 1970s. By creating various approaches, Rosenthal and Rubin (1978) and Schmidt and Hunter (1977) are the first researchers to employ meta-analysis technique in social sciences (Dinçer, 2014).

Glass, McGaw, and Smith (1981) defined meta-analysis as "the quantitative synthesis of results from numerous individual empirical research that focus on the same topic."

Meta analysis is convenient for reaching more certain judgments and drawing conclusions when individual primary research yield contradictory results (Camilli et al, 2008). By using the meta-analysis technique, the researcher can obtain more confident insights compared to the results obtained from individual studies. As a result, the researcher can argue for the efficacy of a particular teaching technique using arguments from several papers that have been gathered for meta-analysis.

5.1 Meta-Analysis Implementation Phases

The first step is to conduct a research on literature. The search procedure for a meta-analysis, like that of a literature review, should be planned and meaningful, correct,

conclude in a data set that contains appropriate researches. (Fisch and Block, 2018; Gusenbauer and Haddaway, 2020). The analysts should determine which papers to get it for meta-analysis while reading the literature. To assure the quality of findings, several recommendations for literature reviews advocate restricting the sample to research published in prestigious academic publications. The relevant literature review papers are gathered so that the researcher may identify the study characteristics and proceed to search for good research questions. They find research questions for these inadequacies and collect studies in this area since it has the ability to detect gaps in the literature. So that the researcher defines the research question or questions. As with any other empirical study, the first step in performing a meta-analysis is to define the research topic. The research topic, most critically, sets area of variables to be investigated or the sort of treatments whose effects will be assessed. The researcher should focus on developing a unique study topic that does not repeat past meta-analyses. Another barrier to determining a sufficient study scope is that relevant studies in such areas in many disciplines of research has expanded rapidly in last years. The researcher should be aware of current publications in the field of study that he is interested in.

Determining the study characteristics allows the criteria to be constructed so that the researcher may identify the significant topics. Following the literature review, those studies that fulfill the inclusion criteria according to the coding technique are assessed among those found in response to the research questions. The most meticulous work is required in selecting the inclusion criteria in the meta-analysis and coding the studies retrieved throughout the literature research. Because the completion of these steps allows for easy accurate analysis and clear interpretation of the study (Dinçer, 2014).

When the researcher has finished deciding coding criteria the analysis may begin. Following the analysis, the effect size calculation and heterogeneity test are performed. The researcher will be able to evaluate the study data after completing the model selection using the heterogeneity test, due to the general effect size calculation. As a result, the study seems to be completed, and the researcher can write reviews on the study's findings, discussion, and conclusion parts.

There is an attempt underway to define a reporting standard for meta-analysis. At the head of these efforts are Rosenthal's criteria as he noted in 1995, that a meta-analysis

research should include a literature review, inclusion criteria, study characteristics, heterogeneity test, effect size value, confidence intervals, and descriptive statistics.

The processes indicated in the title Meta-Analysis Implementation Phases are depicted below. Figure 5.1 below showing implementation of meta-analysis studies created with using MindMup by the researcher.

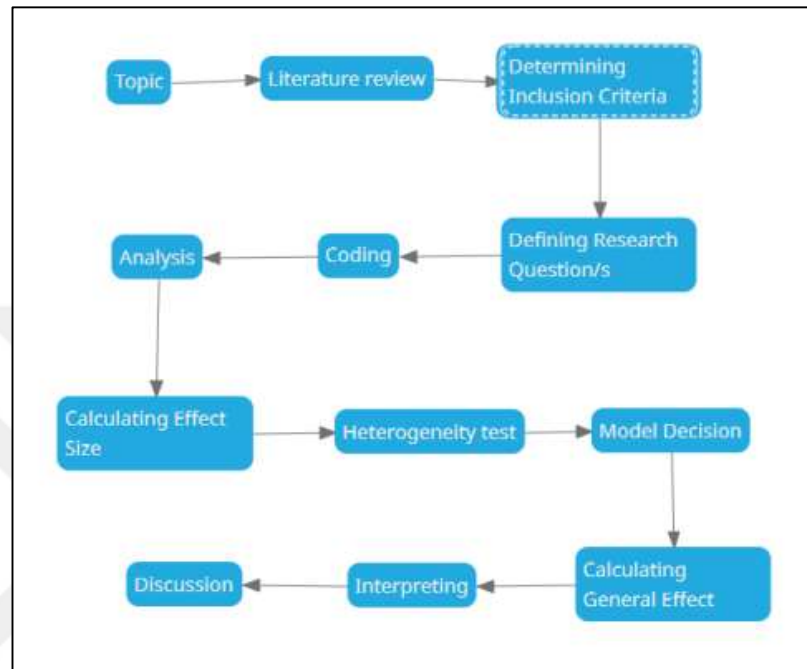


Figure 5.1 : Implementation of meta-analysis.



6. RESEARCH METHODOLOGY

Researches about determination of critical success factors in Agile Project Management within software development sector variables were collected by using the meta-analytic approach, which is considered to be one of the synthesis methodologies. The scope of the study is confined to applications submitted in Turkey and abroad, and studies published between the years 2005 and 2022, respectively. The meta-analysis technique is used to aggregate the findings of the studies statistically.

The meta-analysis technique which is one of the systematic content analysis methodologies, was employed in this study. Meta-analysis is a statistical approach for gathering together studies undertaken by various researchers at multiple places and periods on a specific issue, using the right statistical procedure, or for collecting the information gathered from the studies (Hunter and Schmidt, 1990; Kaşarcı, 2013). This is suggested to combine the results from many research using the effect size coefficients stated in such investigations.

“Determination of Critical Success Factors in Agile Project Management within Software Development Sector: A Meta Analysis” searching the CSFs effecting agile project success which has studied in 86 different studies. Meta-analysis is studied in agile project management success, but researches concentrated on agile project management progress or traditional management progress.

Using weight analysis and meta-analysis, this research seeks to combine the results of earlier research. Scholars could assess the appropriate factors to be utilized in CSF analysis in agile project management through this research.

Firstly, 249 studies published between 2005 and 2022 which include agile project management success gathered. Then, 86 researches seeking agile project management and CSFs were identified. 78 critical succes factors affecting the agile project management success were identified of these 78 CSFs, necessary informations were present and appropriate for 19; hence, the investigation done in this study involved 19 CSFs.

CSFs which have effect on the agile project management success are;

- Agile-oriented Configuration Management Process,
- Project Team Commitment,
- Client Consultation,
- Commitment to Agile Methodology,
- Communication,
- Correct Integration Test Mechanisms,
- Customer Colloboration,
- Delivery Strategy,
- Team Capability,
- Planning and Controlling,
- Project Mission,
- Employee Participation,
- Organizational Culture,
- Team Composition,
- Sustainability,
- Regular Software Delivery,
- Shared Leadership,
- Team Size,
- Requirement Change.

There were 19 hypotheses that the study design was tested on. The correlation coefficient between each variables and study population was used to do the meta-analysis. Weight analysis contains significant, insignificant outputs and frequency number of relationship variables. It is evident that the stage two should make use of meta-analysis by taking into consideration of this analysis.

Meta-analysis outcomes give independent and dependent variables, number of times a particular relationship was conducted, cumulative correlations [Avg (r)], effect sizes

[p(ES)], normal standard deviations (Z-value), and 95% lower and upper confidence interval levels (Albayrak and Ceylan, 2021).

The outcomes illustrate that all relationships are significant. There are strong correlations on agile project management success and sustainability (0.415), regular software delivery (0.441), project mission (0.501), project team commitment (0.511), employee participation (0.526), planning and controlling (0.532), delivery strategy (0.533), communication (0.543), team composition (0.552), organizational culture (0.563), team capability (0.577), commitment to agile methodology (0.588), shared leadership (0.630). In addition, reliability is examined.

This is challenging to draw a definite conclusion on 15 CSFs (Agile-oriented Configuration Management Process, Project Team Commitment, Client Consultation, Commitment to Agile Methodology, Correct Integration Test Mechanism, Delivery Strategy, Project Mission, Employee Participation, Organizational Culture, Team Composition, Sustainability, Regular Software Delivery, Shared Leadership, Team Size, Requirement Change) of agile project management success, which studied fewer than five. Promising CSFs with significant meta-analysis results and strong correlations (e.g. Communication, Customer Collaboration, Team Capability, Planning and Controlling) could be understood as best CSFs and should be contained in next agile project management studies.

6.1 Research Questions

The purpose of this study is to comprehend the CSFs that have effect on the success of agile project management.

The research question seeks for determining of CSFs on agile project management success. In this direction, effects of CSFs on agile project management success are also asked and studied.

6.2 Hypothesis Development and Literature Review

The purpose is to search previous works for the independent variables/constructs. Hypotheses are set in this section.

6.2.1 Agile-oriented configuration management process

ASD progress is significantly influenced by system variables. Venkatesh et al. (2003) argued in favor of Tibenderana et al.'s (2010) examination and verification of this theory's veracity which promoted that agile-oriented configuration management process positively affect to agile project management success. Pedersen (2013) also found positive relationships between agile-oriented configuration management process and agile project management success.

Hypothesis 1: Agile-oriented configuration management process has a positive effect on agile project management success.

6.2.2 Project team commitment

Chow and Cao (2008) researched and found that squad with high commitment positively affect agile software development project within the scope of success. Wan and Wang (2010) found that team commitment affects agile project management success positively. In addition, Ahimbisibwe et al. (2017) found positive correlation on agile project management success with project team commitment

Hypothesis 2: Project team commitment affects agile project management success positively.

6.2.3 Client consultation

Client perception, according to Davis (2014), is crucial to a project's success because it give the deployment group a clear grasp of the program's company requirements (Davis, 2014).

Hayer (2019) found positive relationships between client consultation and agile project management success.

Hypothesis 3: Client consultation process has a positive effect on agile project management success.

6.2.4 Commitment to agile methodology

Commitment to agile methodology refers that management/customer support agile techniques. It is accepted within the organization along with teams committed to agile methods (Syeda, 2018).

Syeda (2018) found positive relationships between commitment to agile methodology and agile project management success.

Hypothesis 4: Commitment to agile methodology affects agile project management success positively.

6.2.5 Communication

The success of a project depends on effective communication throughout the enterprise. Verburg et al. (2013) highlighted the value of dialogue and relationship-building. A direct dialogue strategy will be made possible through developing connections with customers, which, enhance the success of project. Hayer (2019) found positive relationships between communication and agile project management success.

Hypothesis 5: Communication affects agile project management success positively.

6.2.6 Correct integration test mechanism

Correct integration test mechanism can be evaluated as in technical dimension. Technical dimension has different factors such as determined quality of code, adherence to plan and correct integration test (Chow and Cao, 2008). Chow and Cao (2008) found strong correlation on agile project management success with technical factors.

In other studies, Stankovic et al. (2013) and de Souza Mariz et al. (2010) investigated correct integration test mechanism relation with agile project management success. As a result, both study found positive relationships between correct integration test mechanism and agile project management success.

Hypothesis 6: Correct integration test mechanism has a positive effect on agile project management success.

6.2.7 Customer collaboration

Some of the authors who have explicitly or implicitly cited customer dimension as a factor are Lindvall et al. (2002), Cohn and Ford (2003), Nerur et al. (2005), and Turner and Boehm (2003). Client happiness, client collaboration, and customer client adherence are three categories of customer dimension challenges that had taken into consideration.

Collaboration with customers is promoted as a crucial prerequisite for effective computer programming in the Agile Manifesto. Misra et al. (2009) found positive correlation on agile project management success with customer collaboration.

Hypothesis 7: Customer collaboration affects agile project management success positively.

6.2.8 Delivery strategy

Delivery strategy describes how a project is divided into several activities to enable ongoing evaluation and the delivery of client & market focused goods (Syeda, 2018).

Syeda (2018) found positive relationships delivery strategy and agile project management success.

Hypothesis 8: Delivery strategy affects agile project management success positively.

6.2.9 Team capability

Tam et al. (2020) found that client participation, client participation are crucial CSFs for agile project management success. Team capability refers to agile project management squad's skills, experiences and size.

One year after Tam's study, Mohamed (2020) found that team capability has a positive effect on agile project management success and recommended that team capability could be crucial CSFs in the aspect of agile project management success.

Hypothesis 9: Team capability affects agile project management success positively.

6.2.10 Planning and controlling

The degree to which controlling and planning techniques are applied in a business is referred to as planning and controlling. Planning and process quality have a beneficial association, according to earlier study (Yetton et al, 2000; Jun et al, 2011).

A project may be carefully tracked and monitored in accordance with a planning to guarantee that the finished item is delivered on time and within specified budget (Ahimbisibwe et al, 2017). Ahimbisibwe et al. (2017) found that planning and controlling affects agile project management success positively.

Hypothesis 10: Planning and controlling has a positive effect on agile project management success.

6.2.11 Project mission

The project mission explains the program's guiding principles and objectives. The team may comprehend the objective and make sure the result will satisfy the company needs using the values and vision as a guide (Babnik, 2014). Babnik (2014) stresses that a mission should be that the group is in agreement with rather than something that is forced to them. The project mission is a crucial factor in making sure the project objective is established from its inception (Rezvani et al, 2016).

Ahimbisibwe et al. (2017) investigated correct integration test mechanism relation with agile project management success and found that project mission has a positive effect on agile project management success.

Hypothesis 11: Planning and controlling has a positive effect on agile project management success.

6.2.12 Employee participation

Since Mayo's renowned efficiency study at Western Electric's Hawthorne facility, job satisfaction and employee participation have been recognized as critical elements in business growth and leadership (Mayo, 1933; Mayo, 1945).

The premise that knowledge and strategic edge may arise from an institutional climate that creates a range of viewpoints viewpoints, as well as for creativity and invention, and for demonstrating respect for other people's opinions, are all dependent on employee participation (Mart, 1992; Scheing, 1996).

Dyba (2005) investigated employee participation relation with agile project management success and found that employee participation affects agile project management success positively.

Hypothesis 12: Employee participation affects agile project management success positively.

6.2.13 Organizational culture

Agile project success rates are positively impacted by organizational culture, particularly an uncertainty mindset (Misra et al, 2009; Sheffield and Lemétayer, 2013). Nevertheless, reports on the impact of an agile corporate culture on the effectiveness of software projects have produced some contradictory findings. For instance, while

Misra et al. (2009) and Wan and Wang (2010) found that corporate culture affects project success, Chow and Cao (2008) couldn't see that corporate culture affects the project success. Strode et al. (2009) researched and concluded that organizational culture has important effect on project success.

Ahimbisibwe et al. (2017) investigated organizational culture relation with agile project management success and found that organizational culture has a positive effect on agile project management success.

Hypothesis 13: Organizational culture affects agile project management success positively.

6.2.14 Team composition

According to Chow and Cao (2008), cross-functional squads with client participation helped agile development projects succeed in terms of scope but not in terms of duration, money, or excellence. Likewise, Nah and Delgado (2006) discovered that software projects were executed effectively when the strongest were on the organization, there were fair cross-functional squads, and everyone was working full time.

Small squads with the finest skills and knowledge are needed for agile approaches as opposed to waterfall approach (Sheffield and Lemétayer, 2013).

Ahimbisibwe et al. (2017) investigated team composition relation with agile project management success and found that team composition has a positive effect on agile project management success.

Hypothesis 14: Team composition affects agile project management success positively.

6.2.15 Sustainability

Reduced shift and ambiguity costs, the situation of well development are referred to as sustainability (Syeda, 2018).

Syeda et al. (2018) investigated sustainability relation with agile project management success and found that sustainability affects agile project management success positively.

Hypothesis 15: Sustainability affects agile project management success positively.

6.2.16 Regular software delivery

Applying an agile methodology encourages rapid product supply, followed by UAT (User Acceptance Test), for which the product owner must be on hand to facilitate fast testing of something like the features as they are given and throughout the whole operation. This process could be lengthy but it greatly increases the likelihood that the final result will be of excellent caliber and match users' demands. According to the comments, agile approach is psychologically depleting for devs since they must finish every function completely inside every step. It is crucial to have a squad speed that is sustainable (Flora and Chande, 2014).

De Souza Mariz et al. (2010) researched regular software delivery relation with agile project management success and found that regular software delivery affects agile project management success positively.

Hypothesis 16: Regular software delivery affects agile project management success positively.

6.2.17 Shared leadership

In two of the models discussed, shared leadership is evident in the form of team leadership. According to this research, shared leadership is the capacity to organise, analyze quality of play, assign tasks, and foster a positive environment while also coordinating and directing the work of other teammates (Salas et al, 2005).

Leadership must be decentralized instead of centralized, particularly in self-managing Scrum squads (Morgan, 2006). Meurs et al. (2015) researched shared leadership relation with agile project management success and found that shared leadership has a positive effect on agile project management success.

Hypothesis 17: Shared leadership affects agile project management success positively.

6.2.18 Team size

According to Nguyen (2016), the agile squad requires practical agile engineering techniques, suitable software and development tools, acceptable agile project management procedures, and customer involvement and effectiveness, which is consistent with earlier publications on critical success factors. Lalsing (2012) emphasized that team size is a crucial CSF on project success.

Mohamed (2021) investigated team size relation with agile project management success and found that team size affects agile project management success positively.

Hypothesis 18: Team size affects agile project management success positively.

6.2.19 Requirement change

It is generally agreed upon that every modification to requirements are not favored by the project squad. Although they may be manageable at first, the further in the program's lifespan they appear, the greater risk they pose to the project's success (Dennis, 2007). Businesses use complicated business technologies to control and trace adjustments during the project, based on variables like cost, time, or the number of attendees (Gunduz and Hanna, 2005).

Maierhofer et al. (2010) researched requirement change relation with agile project management success and found that requirement change affects agile project management success positively.

Hypothesis 19: Requirement change has a positive effect on agile project management success.

6.3 Data Collection

The study purpose is to understand the critical success factors that affect the agile project management success. To achieve purpose, appropriate keywords were determined and researched by using Emerald, ProQuest, Google Scholar, ScienceDirect, Elsevier, Springer and ITU library during the data collection of meta-analysis. Commonly searched words are; agile, agile project management, agile project management success, critical success factors and agile, agile project and correlation, critical success factor in agile. The periods covered by the publications range from 2005 to now. There were 249 studies that were explicitly relevant to the topic. The count was decreased to 86 by removing studies without necessary information. The count was lowered to 21 once the specific statistical data, such as correlation coefficients, p values, and data sets, were taken into account. The study population was decided upon and built on 14 studies after the studies in the analysis pool that were methodologically flawed and did not comply with the import

requirements were eliminated. The internal consistency of the study in meta-analysis is improved by this grouping. Figure 6.1 shows the research model.

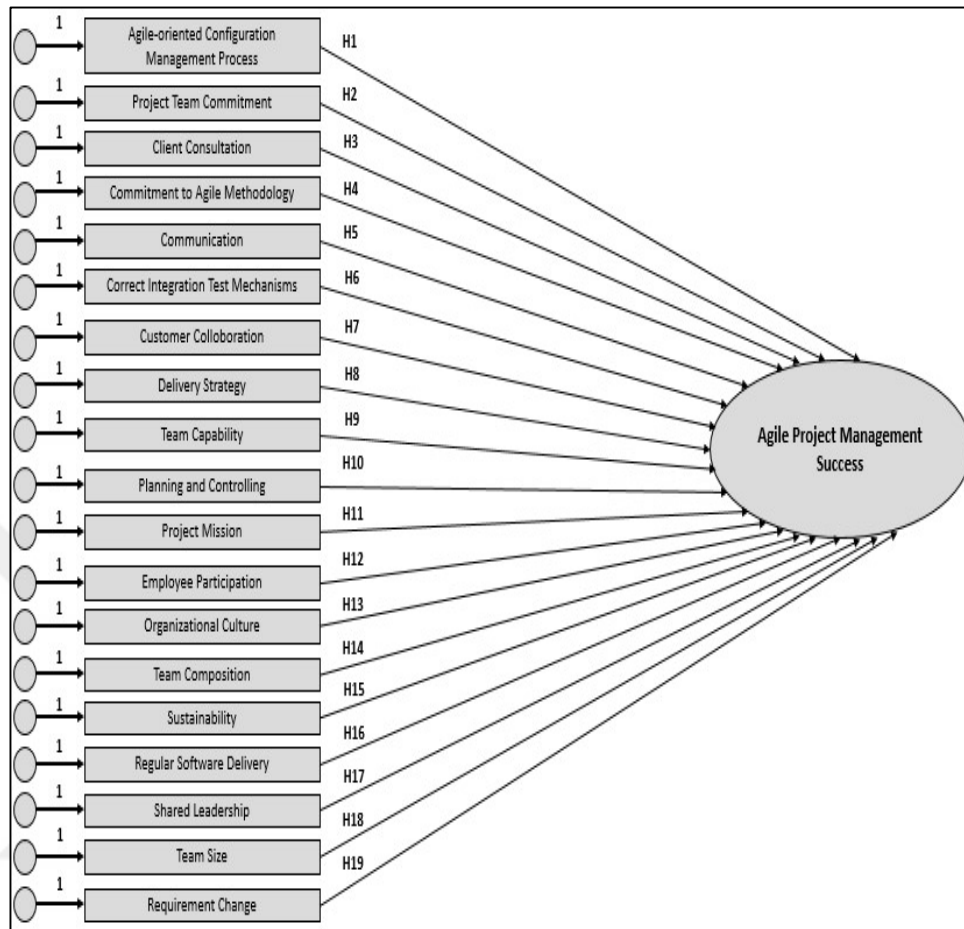


Figure 6.1 : Research model.

6.4 Coding

To identify the researches that meet the requirements to be included in the meta-analysis and to make comparisons among researches that will be considered for the meta-analysis, a coding approach has been devised in the research in line with the goal of the research. The one of the most crucial steps done to improve the study's internal dependability is the coding system utilized to create the data collection. A coding form is finished independently for every investigation.

Author name and publication year, publish year, study name, publication type, country, database, sample size and correlation value r titles are contained in coding of study. The coding form is not only a guarantee of the internal reliability of the study. It also supports the external validity of meta-analysis studies by giving a detailed description

of the study to descendent analysers. The researches were coded according to the title's classification, and the data were gathered. Table 6.1 shows the coding.

After completion of coding step, the effect size values are determined to used in meta-analysis. The gathered researches depict statistical values such as t-test, correlation, regression, chi-square, etc. The collected data should have been transformed to effect size, which is a standardized metric of measurement, for combining statistical data from several researches in meta-analysis. Impact sizes should be indicated on a common scale. In this study, the correlation(r) indicates the relationship between the two variables. The correlation (r) will be also used for assessment of the effect size. On account of this, correlation (r) value is coded for each run in the coding table (Albayrak and Ceylan, 2021).

In Table 6.2, research informations such as publication year, publication type, database and country are presented to summarize study with frequency informations.

Table 6.1 : Meta-analysis coding.

Study Number	Author(s)	Publish Year	Study Name	Publication Type	Country	Database	Sample Size	r (Correlation)
1	Misra et al.	2015	Identifying some important success factors in adopting agile software development practices	Journal article	Canada	Elsevier	174	0.381
2	Dyba	2005	An empirical investigation of the key factors for success in software process improvement	Journal article	Norway	IEEEExplore	120	0.760
3	de Souza Mariz et al.	2010	An empirical study on the relationship between the use of agile practices and the success of software projects that use Scrum	Journal article	Brazil	IEEEExplore	62	0.441
4	Meurs	2015	Determining the success factors of Scrum projects	Master thesis	Holland	Google scholar	116	0.780
5	Ahimbisibwe et al.	2017	Empirical comparison of traditional plan-based and agile methodologies: Critical success factors for outsourced software development projects from vendors' perspective	Journal article	New Zealand	Emerald	471	0.530
6	Syeda	2018	An exploratory study to identify critical success factors of agile systems engineering	Doctorate thesis	USA	ProQuest	46	0.790
7	Sheffield and Lemétayer	2013	Factors associated with the software development agility of successful projects	Journal article	New Zealand	ScienceDirect	106	0.730
8	Pedersen	2013	A quantitative examination of critical success factors comparing agile and waterfall project management methodologies	Doctorate thesis	USA	Google scholar	49	0.550
9	Greene	2022	Organizational, technical, and process factor relationship on agile IT project success	Doctorate thesis	USA	ProQuest	103	0.800
10	Maierhofer et al.	2010	Requirement changes and project success: The moderating effects of agile approaches in system engineering projects	Journal article	Austria	Springer	72	0.300
11	Stankovic et al.	2013	A survey study of critical success factors in agile software projects in former Yugoslavia IT companies	Journal article	Serbia	Elsevier	23	0.903
12	Mohamed	2021	Critical success factors for the application of agile methodology in IT telecommunication projects: A mixed method research approach	Doctorate thesis	USA	ProQuest	150	0.778
13	Haskin	2022	Agile software development and successful project completion: A quantitative study	Doctorate thesis	USA	ProQuest	150	0.778
14	Hayer	2019	The impact of preplanning activities on IT project success: A correlational study	Doctorate thesis	USA	ProQuest	125	0.690

Table 6.2 : Study features with frequency.

Variable	F	Percentage Value (%)
Year of publication		
2005	1	7%
2010	2	14%
2013	3	21%
2015	2	14%
2017	1	7%
2018	1	7%
2019	1	7%
2021	1	7%
2022	2	14%
Total	14	100%
Publication type		
Master thesis	1	7%
Doctorate thesis	6	43%
Journal article	7	50%
Total	14	100%
Database		
Emerald	1	7%
Springer	1	7%
ScienceDirect	1	7%
IEEEExplore	2	14%
Elsevier	2	14%
Google scholar	3	21%
ProQuest	4	29%
Total	14	100%
Country		
Austria	1	7%
Brazil	1	7%
Canada	1	7%
England	1	7%
Holland	1	7%
Norway	1	7%
Serbia	1	7%
New Zealand	2	14%
USA	5	36%
Total	14	100%

6.5 Model Selection in Meta-Analysis

The decision made during model selection will determine how the subsequent processes will go, making it among the most crucial steps. Lipsey and Wilson (2001)

recommends selecting any of the random, fixed, or mixed-effects models to find the origin of any potential data heterogeneity (Glass, 1976).

In fixed-effect model, heterogeneity was low among the studies. All studies are considered to estimate the same impact. Therefore, the effect size same across all researches. Diversity is simply a result of the respondents' sample size.

Heterogeneity among the researches is high in the random effects model.

In the random effects model, heterogeneity between studies is high. It makes the assumption that research can forecast various real effects. Therefore, the actual effect size varies across the researches. The sampling of the respondents did not generate diversity. Additionally, it results from the variations in the researches. Unpredictability exists. The choice among the two models determines whether researches has heterogeneity or not (Albayrak and Ceylan, 2021).

In the course of analysis, Comprehensive Meta-Analysis (CMA) was chosen to conduct meta-analysis. In CMA, heterogeneity tests were carried out.

6.5.1 Heterogeneity test

There are two techniques to determine whether a study is heterogeneous:

1. If the confidence intervals for the research's findings have little or no intersection, revealing the presence of heterogeneity. It can be understood by drawing the forest plot.
2. Cochran Q or I² statistics are applied.

By examining the p-value, the Cochran Q statistic determines whether there is considerable heterogeneity.

There is suitable heterogeneity if the I² statistic is between 50 and 75%. If the I² statistic is between 75% and 100%, there is a high level of heterogeneity. Examining both control steps allowed researchers in this research to identify heterogeneity (Albayrak and Ceylan, 2021).

6.5.2 Random effects model

First, the Forrest plot, which is depicted in Figure 6.2 and was created as a consequence of a meta-analysis in CMA, was investigated. Because each confidence interval does

not overlap, as can be observed in the random-effects model on the right-hand side, there is heterogeneity with the initial control.

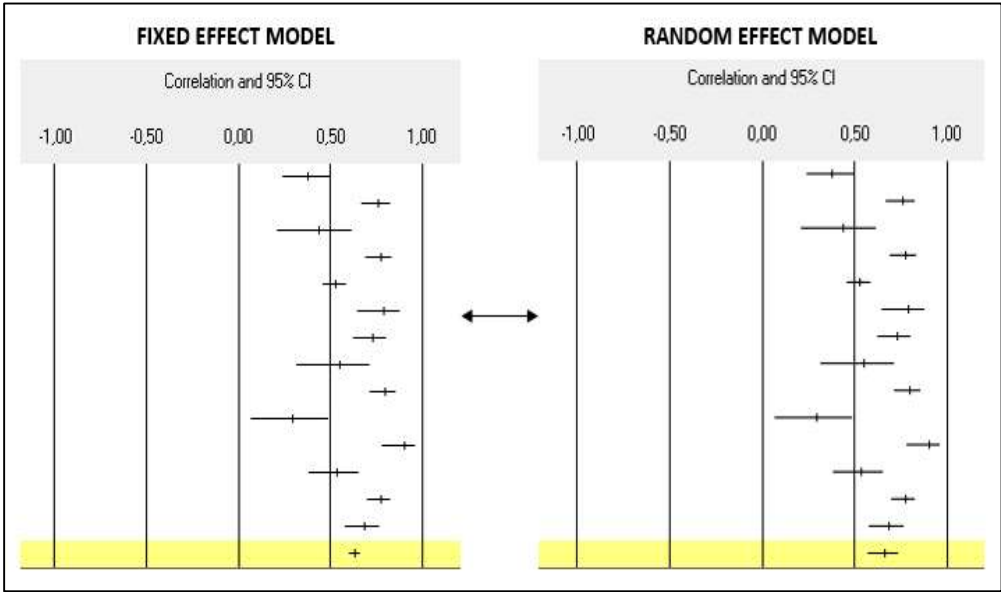


Figure 6.2 : Forest plots.

Figure 6.3 shows the output of meta-analysis data set. The p-value shown in Figure 6.3 has been further checked. Because the p-value is less than 0.1, it is heterogeneous. According to the I2 statistic, there is 88% heterogeneity. The research will progress by using a random-effects model with all of these controls (Albayrak and Ceylan, 2021).

Model	Effect size and 95% interval				Test of null (2-Tail)		Heterogeneity				Tau-squared			
Model	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
Fixed	14	0,634	0,604	0,661	30,678	0,000	115,103	13	0,000	88,706	0,069	0,037	0,001	0,263
Random	14	0,668	0,576	0,743	10,539	0,000								

Figure 6.3 : Output of meta-analysis data set.

6.5.3 Possible causes heterogeneity

In the previous section, heterogeneity of study is calculated as 88%. Possible causes of heterogeneity are as follows:

1. Various operating methods,
2. Quality of research,
3. Work selection causes bias,
4. Other impacts of bias,
5. Various statistical techniques are applied.

6.6 Calculation of Common Effect Size of Studies (Effect Size of Model)

The average effect size value is determined from the gathered researches. The common effect of the 14 studies is 0.668. Figure 6.3 and Figure 6.4 depict the common effect size. 0.668 shows the common effect of CSFs on agile project management success over 14 researches. The common effect size of researches and the common effect size of independent variables are unique and distinct. The size of the researches is examined in this stage.

Figure 6.4 illustrates the correlation value of each research(r), common r value and forest plot of random effect's model for the 14 researches as a consequence of the meta-analysis. The diamond sign on the forest plot denotes the correlation value of 0.668, and Figure 6.3's point estimate displays the same value. In meta-analysis result, an effect value between 0.5 and 0.75 is considered to be fairly good. The weight for every run is indicated by the size of the square boxes that appear for every 14 researches, excluding the diamond symbol. Weights were discovered to be extremely close to one another in overall. 95% confidence intervals have been given at the lines' two ends (Albayrak and Ceylan, 2021).

Meta Analysis

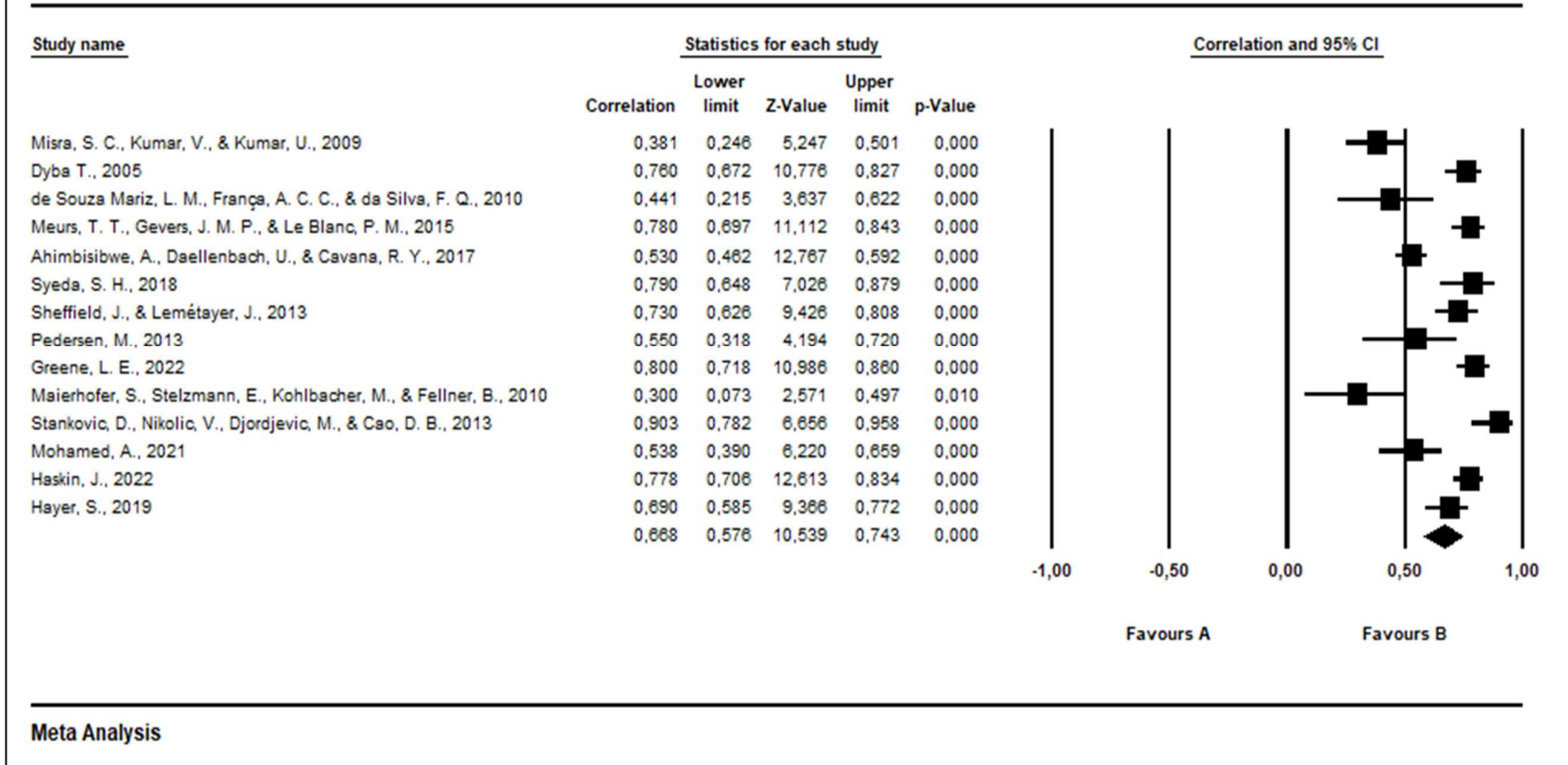


Figure 6.4 : Meta-analysis diagram showing the impact direction of the studies separately.

6.7 ANOVA Analyses for Heterogeneity

To find reasonable causes of heterogeneity, ANOVA analysis is conducted. For this research, the CMA software is also utilized.

For analysis given in the Table 6.3, only studies published in the USA are reviewed and examined. The filtered criteria are given in red. The degree of heterogeneity dropped from 88% to 61%. Figure 6.5 depicts the consequence of a meta-analysis in CMA for the determined five researches.

The sample size was also the subject of an ANOVA analysis because it is a coding criterion. Since there was no obvious change in heterogeneity, specific details were not given.

6.8 Funnel and Forest Plots

To show the validity of a meta-analysis and the CMA results, publishing bias is assessed. The number of conflicted researches that should be added in the sample in order to disprove the average effect size determined by the meta-analysis is represented by this value. The analysis publication bias path is used to assess the strength of the analysis. In conclusion, 3,287 research which indicate CSFs negatively impact on agile project management success to be added to the existing sample in order to reject the conclusions from the 14 research that was part of the meta-analysis in this study, given in Figure 6.6.

Due to the fact that only released and meaningful studies were included in the meta-analysis, a funnel plot is utilized to examine any potential publication bias. The funnel graph's asymmetry is an indication of publishing bias. As seen by Figure 6.7, there is no publication bias in the meta-analysis of this study.

Table 6.3 : Studies selected for analysis.

Study Number	Author(s)	Publish Year	Study Name	Publication Type	Country	Database	Sample Size	r (Correlation)
6	Syeda	2018	An exploratory study to identify critical success factors of agile systems engineering	Doctorate thesis	USA	ProQuest	46	0.790
8	Pedersen	2013	A quantitative examination of critical success factors comparing agile and waterfall project management methodologies	Doctorate thesis	USA	Google scholar	49	0.550
9	Greene	2022	Organizational, technical, and process factor relationship on agile IT project success	Doctorate thesis	USA	ProQuest	103	0.800
13	Haskin	2022	Agile software development and successful project completion: A quantitative study	Doctorate thesis	USA	ProQuest	150	0.778
14	Hayer	2019	The impact of preplanning activities on IT project success: A correlational study	Doctorate thesis	USA	ProQuest	125	0.690

Model	Effect size and 95% interval				Test of null (2-Tail)		Heterogeneity				Tau-squared			
	Number Studies	Point estimate	Lower limit	Upper limit	Z-value	P-value	Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
Fixed	5	0,745	0,702	0,783	20,595	0,000	10,300	4	0,036	61,166	0,018	0,022	0,000	0,135
Random	5	0,739	0,661	0,801	12,100	0,000								

Figure 6.5 : Selected data's output.

Classic fail-safe N	
Z-value for observed studies	30,09249
P-value for observed studies	0,00000
Alpha	0,05000
Tails	2,00000
Z for alpha	1,95996
Number of observed studies	14,00000
Number of missing studies that would bring p-value to > alpha	3287,00000

Figure 6.6 : Bias value calculation.

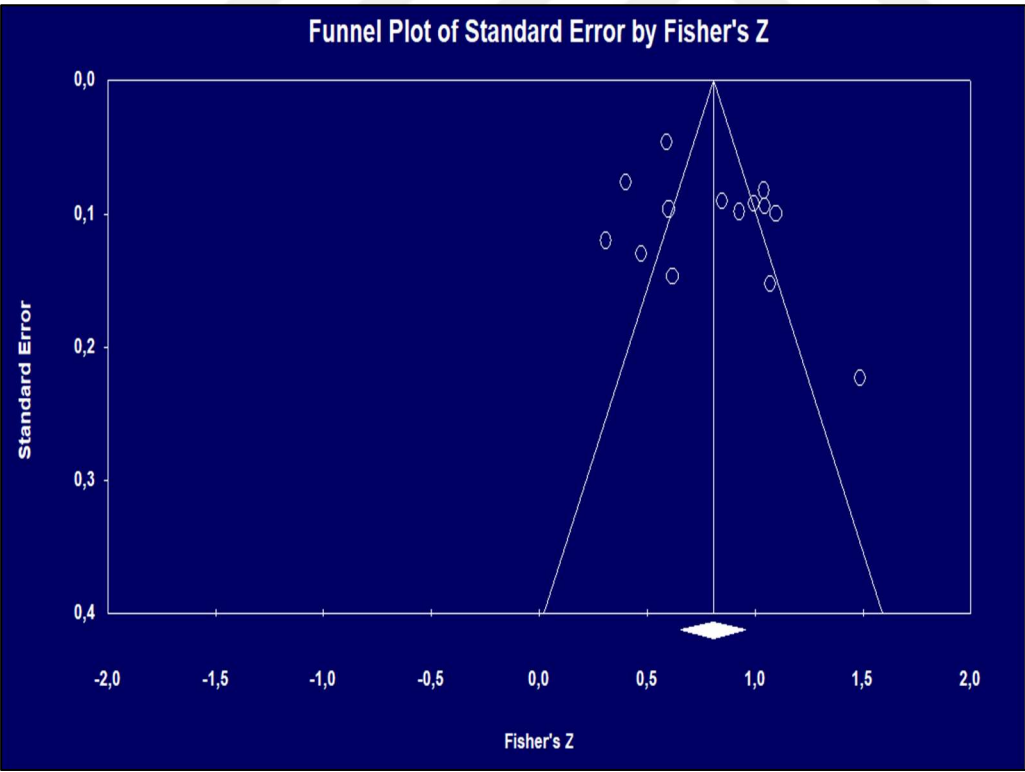


Figure 6.7 : Funnel plot.

6.9 Calculation of Common Effect Sizes for Independent Variables

Meta-analysis is referred to as a technique for statistically integrating quantitative findings from several empirical investigations in order to display the research backdrop (Glass, 1976). The findings of the meta-analysis of 19 connections across 14 studies are presented in Table 6.4. This table's correlation values were all extracted by using the CMA software. The correlation value (r) of 19 variables are provided within Figure 6.3. The findings were carefully entered in Table 6.4 to prevent visual multiplicity. For instance, the phrase "communication" is used in five studies, each of which assigns a different r value to it. As a result, the CMA processes the r values and sample sizes from each of the five studies to produce a single r (correlation) value.

CMA program requires correlation values (r) and sample sizes in order to determine common effect sizes. For example, the Agile-oriented Configuration Management Process, r (point estimate) value is 0.354. In which articles the variables are mentioned can be seen in Table 6.5. Table 6.4 gives dependent and independent variables; correlation(r) value, p and z values indicate the upper and lower limits of r values. Meta-analysis consequence depicts that 19 out of 19 relationships are significant. There is a strong relationship between shared leadership ($r = 0.630$), commitment to agile methodology ($r = 0.588$), team capability ($r = 0.577$), organizational culture ($r = 0.563$), team composition ($r = 0.552$), communication ($r = 0.543$), delivery strategy ($r = 0.533$), planning and controlling ($r = 0.532$), employee participation ($r = 0.526$), project team commitment ($r = 0.511$), project mission ($r = 0.501$), regular software delivery ($r = 0.441$), sustainability (0.415) and agile project management success. Commitment to agile methodology is included in only two studies handled in meta-analysis. If more studies were considered, the variables would have a high correlation and it would change the results.

There is a weak relationship between customer collaboration ($r = 0.357$), agile-oriented configuration management process ($r = 0.354$), correct integration test mechanism ($r = 0.316$), client consultation ($r = 0.307$), requirement change ($r = 0.300$), team size ($r = 0.255$) and agile project management success. However, since variables can found in only one article included meta-analysis such as shared leadership, regular software delivery, correct integration test mechanism, client consultation, requirement change and team size, commenting on the relationships' strengths or weakness would

not be appropriate. There was no powerful relationship between agile project management and shared leadership, regular software delivery, correct integration test mechanism, client consultation, requirement change and team size.

Figure 6.8 illustrates the relationships for the independent and dependent variables. The combined correlation of the variables which calculated in the meta-analysis is given on the figure as a unique result of each variable.

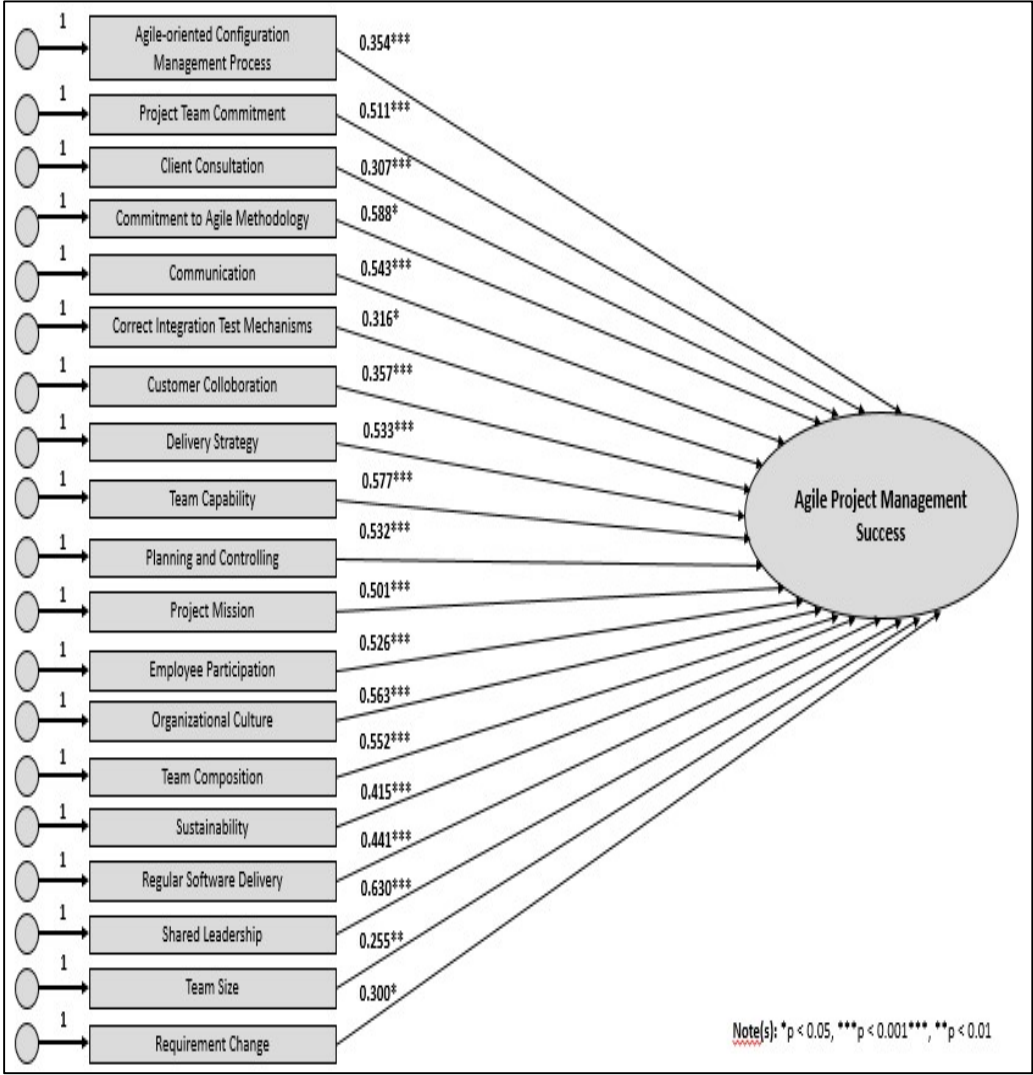


Figure 6.8 : Correlations among independent variables and agile project management success.

Table 6.4 : Result of meta-analysis for each recorded variable.

Independent Variable	Dependent Variable	Study Count	R (Point Estimate)	p-value	Z-value	Lower limit	Upper limit
Agile-oriented Configuration Management Process	Agile Project Management Success	2	0.354	0.000	3.80	0.18	0.51
Project Team Commitment		4	0.511	0.000	0.41	0.41	0.60
Client Consultation		1	0.307	0.000	3.50	0.14	0.46
Commitment to Agile Methodology		2	0.588	0.036	2.10	0.04	0.86
Communication		5	0.543	0.000	8.22	0.43	0.64
Correct Integration Test Mechanisms		1	0.316	0.012	2.51	0.07	0.52
Customer Colloboration		5	0.357	0.000	7.81	0.27	0.44
Delivery Strategy		3	0.533	0.000	4.07	0.30	0.71
Team Capability		5	0.577	0.000	8.55	0.47	0.67
Planning and Controlling		5	0.532	0.000	5.76	0.37	0.66
Project Mission		4	0.501	0.000	4.44	0.30	0.66
Employee Participation		2	0.526	0.000	14.14	0.47	0.58
Organizational Culture		4	0.563	0.000	5.03	0.37	0.71
Team Composition		4	0.552	0.000	16.97	0.50	0.60
Sustainability		2	0.415	0.000	4.17	0.23	0.57
Regular Software Delivery		1	0.441	0.000	3.64	0.21	0.62
Shared Leadership		1	0.630	0.000	7.88	0.51	0.73
Team Size		1	0.255	0.007	2.70	0.07	0.42
Requirement Change		1	0.300	0.010	0.50	0.07	2.57

Note(s): *p < 0.05, ***p < 0.001***, **p < 0.01

Table 6.5 : Agile project management success' variable frequency.

Variable No	Variable	Study Number	Author(s) (Year)
1	Agile-oriented configuration management process	3	de Souza Mariz et al, 2010
1	Agile-oriented configuration management process	8	Pedersen, 2013
3	Project team commitment	2	Dyba, 2005
3	Project team commitment	5	Ahimbisibwe et al, 2017
3	Project team commitment	8	Pedersen, 2013
3	Project team commitment	13	Haskin, 2022
6	Client consultation	14	Hayer, 2019
8	Commitment to agile methodology	6	Syeda, 2018
8	Commitment to agile methodology	8	Pedersen, 2013
9	Communication	4	Meurs, 2015
9	Communication	5	Ahimbisibwe et al, 2017
9	Communication	6	Syeda, 2018
9	Communication	12	Mohamed, 2021
9	Communication	14	Hayer, 2019
10	Correct integration test mechanisms	3	de Souza Mariz et al, 2010
12	Customer colloboration	1	Misra et al, 2009
12	Customer colloboration	3	de Souza Mariz et al, 2010
12	Customer colloboration	8	Pedersen, 2013
12	Customer colloboration	12	Mohamed, 2021
12	Customer colloboration	13	Haskin, 2022
13	Delivery strategy	3	de Souza Mariz et al, 2010
13	Delivery strategy	6	Syeda, 2018
13	Delivery strategy	13	Haskin, 2022
14	Team capability	4	Meurs, 2015
14	Team capability	7	Sheffield and Lemétayer, 2013
14	Team capability	8	Pedersen, 2013
14	Team capability	12	Mohamed, 2021
14	Team capability	13	Haskin, 2022
19	Planning and controlling	2	Dyba, 2005
19	Planning and controlling	5	Ahimbisibwe et al, 2017
19	Planning and controlling	6	Syeda, 2018
19	Planning and controlling	9	Greene, 2022
19	Planning and controlling	14	Hayer, 2019
20	Project mission	5	Ahimbisibwe et al, 2017
20	Project mission	8	Pedersen, 2013
20	Project mission	11	Stankovic et al, 2013
20	Project mission	14	Hayer, 2019

Table 6.5 (continued) : Agile project management success' variable frequency.

Variable No	Variable	Study Number	Author(s) Year
21	Employee Participation	2	Dyba, 2005
21	Employee Participation	5	Ahimbisibwe et al, 2017
24	Organizational Culture	1	Misra et al, 2009
24	Organizational Culture	5	Ahimbisibwe et al, 2017
24	Organizational Culture	7	Sheffield and Lemétayer, 2013
24	Organizational Culture	9	Greene, 2022
26	Team Composition	4	Meurs, 2015
26	Team Composition	5	Ahimbisibwe et al, 2017
26	Team Composition	6	Syeda, 2018
26	Team Composition	14	Hayer, 2019
28	Sustainability	6	Syeda, 2018
28	Sustainability	8	Pedersen, 2013
30	Regular Software Delivery	3	de Souza Mariz, 2010
31	Shared Leadership	4	Meurs, 2015
39	Team Size	12	Mohamed, 2021
40	Requirement Changes	10	Maierhofer et al, 2010

6.10 Analysis Results and Discussion

Agile approaches have started to become more popular today, which has led to an increase in agile initiatives. In competitive world, each organization are trying to get success. To get success in agile project management, each critical factors has a crucial role. As a result, it is critical to discuss and evaluate the findings.

To investigate the critical success factors on agile project management success, 19 hypotheses have been proposed. Each hypotheses' p-values were found significant. So, none of the hypotheses are rejected by taking into consideration of p-values.

- The H1 hypothesis was accepted, meaning that agile-oriented configuration management process showed a positive correlation with agile project management success. But the correlation coefficient was low. Several researhes support this result (Pedersen, 2013; de Souza Mariz et al, 2010).
- From the same point of view with H1 hypothesis result, H3, H6, H7, H18 and H19 hypotheses were accepted. For critical success factors (with some other studies) respectively; client consultation (Hayer, 2019), correct integration test mechanism (de Souza Mariz et al, 2010), customer colloboration (Misra, 2009;

Mohamed, 2021; Haskin, 2022; de Souza Mariz et al, 2010; Pedersen, 2013), team size (Mohamed, 2021) and requirement changes (Maierhofer et al, 2010) have a positive correlation with agile project management success.

- The H2 hypothesis was determined as significant. There is high correlation. Project team commitment, Ahimbisibwe et al. (2017), Haskin (2022) showed a positive relationship with the agile project management success. The H2 hypothesis was accepted.
- The H4 hypothesis was determined as significant. There is high correlation. Perceived comprehensiveness, Syeda (2018), Pedersen (2013) showed a positive correlation with the agile project management success. The H4 has been accepted.
- With the H5, it could be understood that the communication positively affects agile project management success. Several researches support this result (Hayer, 2019; Meurs, 2015; Syeda, 2018). The H5 hypothesis was accepted.
- The H8 was accepted. Several researches support this result (Syeda, 2018; Haskin, 2022; de Souza Mariz et al, 2010).
- The positive outputs of the hypotheses match the results of some studies in the literature (with some other studies); H9 (Haskin, 2022; Mohamed, 2021), H10 (Ahimbisibwe et al, 2017), H11 (Hayer, 2019), H12 (Dyba, 2005), H13 (Sheffield and Lemétayer, 2013; Ahimbisibwe et al, 2017; Greene, 2022), H14 (Ahimbisibwe et al, 2017; Meurs, 2015), H15 (Syeda, 2018), H16 (de Souza Mariz et al, 2010) and H17 (Meurs, 2015). Thus, H9, H10, H11, H12, H13, H14, H15, H16 and H17 hypotheses were accepted.

In total, 14 studies were analyzed in CMA within the scope of meta-analysis. Moreover, it will be helpful for future studies to review as many studies as possible in order to arrive at more realistic and exact results. For instance, it is feasible that the concept of agile project management success will differ significantly depending on whether it is quantified using statistical numbers from only one article or values from 30 studies.

7. CONCLUSIONS AND RECOMMENDATIONS

In this study, determination of critical success factors for agile project management success was aimed to examine, and a literature analysis was done using keywords chosen for this specific reason. In the initial phase of the data gathering process, it was intended to locate all research on agile project management in all countries; thus, all relevant databases were thoroughly reviewed. After then, 249 studies that satisfied the inclusion criteria were included. In total, 86 studies were found and 78 CSFs were identified. 14 of studies met the inclusion criteria and were thus included in the analysis. From 14 studies, necessary informations were exist and appropriate for 19 CSFs, thus 19 CSFs were subject to the analysis conducted in this study. In the second phase, the studies which searching CSFs on agile project management success in all countries were evaluated, and based on this evaluation, the research was detailed to include studies with study year, publication type and databases informations. In this manner, detailed informations of studies were accessed and put into data set.

Examining the publication type of the studies included in the meta-analysis reveals that the majority of the research are articles, with master's theses and doctorate theses being included in the study. In addition, when the languages of the published research are analyzed, it is shown that the majority of studies are written in English. The academic years with the highest studies are 2010-2013 and 2015-2022, based on the years in which the studies were conducted.

In terms of the nations where the studies were conducted, five were executed in the United States, two were conducted in New Zeland and one was conducted in Austria, Brazil, Canada, England, Holland, Norway and Serbia. None of the study from Turkey was taken in meta-analysis because of the lack of matched study, but this study will be one of the pioneer study and shed light on Turkey. The United States and the New Zeland have the highest frequency of studies among these nations.

Most frequently used database was Google Scholar during the study. Other databases which were being used in study are ProQuest, Emerald, Springer, ScienceDirect, IEEEExplore and Elsevier.

In order to get insight into the quality of the studies included in the study, the reliability values of the studies were examined and seen that cronbach alpha reliability test results were appropriate in all studies which are gathered for meta-analysis.

In the course of analysis, Comprehensive Meta-Analysis (CMA) was chosen to conduct meta-analysis. The included studies were merged using the meta-analysis technique. Directions and magnitudes of the effects were computed. According to the fixed-effects model, the total effect size of these investigations was calculated to be 0.634. Heterogeneity tests were conducted in CMA.

The heterogeneity test indicates, however, that the effect size distribution is diverse. High degree of heterogeneity was observed. Therefore, the random-effects model was chosen over the fixed-effects model for this investigation. The total effect size of the studies included in the meta-analysis was determined to be 0.668 by using the random-effects model. According to Cohen's (1988) criteria, this is a somewhat favorable (moderate) effect. This demonstrates that critical success factors affect the agile project management success. In addition, the lack of a research with a negative impact size in this study is evidence of its efficacy, and the outcome of the meta-analysis study is compatible with the relevant literature.

In this study, publication bias was evaluated before beginning the meta-analysis procedure. The funnel plot was assessed for publication bias. Since the studies in the studied graph were not symmetrical, suggesting the likelihood of publishing bias. As a consequence of these detailed tests, it was determined that publication bias did not exist. Moreover, 3,287 research which indicate CSFs negatively impact on agile project management success to be added to the existing sample in order to reject the conclusions from the 14 studies that were part of the meta-analysis in the current study.

The significance of the heterogeneity test done in this study suggests that the variation in effect size among the studies included in the meta-analysis should be investigated. To conduct this study, dependent variables (critical success factors) were analyzed and independent variable decided as agile project management success. In this study, the dependent variables are agile-oriented configuration management process, project team commitment, client consultation, commitment to agile methodology, communication, correct integration test mechanisms, customer collaboration, delivery strategy, team capability, planning and controlling, project mission, employee

participation, organizational culture, team composition, sustainability, regular software delivery, shared leadership, team size and requirement change.

After literature review, different studies were checked for the independent variables and hypotheses were set according to the 19 CSFs.

The findings of the meta-analysis of 19 connections across 14 studies are presented in All correlation values were extracted by using the CMA software. The findings were carefully entered to prevent visual multiplicity. For instance, the phrase "communication" is used in five studies, each of which assigns a different r value to it. As a result, the CMA processes the r values and sample sizes from each of the five studies to produce a single r (correlation) value.

CMA program requires correlation values (r) and sample sizes in order to determine common effect size. For example the Agile-oriented Configuration Management Process, r (point estimate) value is 0.354. Meta-analysis consequence depicts that 19 out of 19 relationships are significant. There is a strong relationship between shared leadership ($r = 0.630$), commitment to agile methodology ($r = 0.588$), team capability ($r = 0.577$), organizational culture ($r = 0.563$), team composition ($r = 0.552$), communication ($r = 0.543$), delivery strategy ($r = 0.533$), planning and controlling ($r = 0.532$), employee participation ($r = 0.526$), project team commitment ($r = 0.511$), project mission ($r = 0.501$), regular software delivery ($r = 0.441$), sustainability (0.415) and agile project management success.

CMA program requires correlation values (r) and sample sizes in order to determine common effect size. For example the Agile-oriented Configuration Management Process, r (point estimate) value is 0.354.

There is a weak relationship between customer collaboration ($r = 0.357$), agile-oriented configuration management process ($r = 0.354$), correct integration test mechanism ($r = 0.316$), client consultation ($r = 0.307$), requirement change ($r = 0.300$), team size ($r = 0.255$) and agile project management success.

It could be said that CSFs which have strong relationship between agile project management success are more related with social motivation factors. When CSFs which have weak relationship between agile project management success are more related with technical factors, it could be understood that social motivation factors

have stronger relationship with agile project management success rather than technical factors.

There might be conclusion that CSFs which have strong relationship with agile project management affect success in social dimension which is an important part of agile project management. Agile project management gives more importance to individuals and interactions than processes and tools which are related with technic. Thus, CSFs with social motivation could more affect agile project management success than technical factors do.

However, since variables can found in only one article included meta-analysis such as shared leadership, regular software delivery, correct integration test mechanism, client consultation, requirement change and team size, it can be said that commenting on the relationships' strengths or weakness would not be appropriate.

As a conclusion, 19 relationships were extracted from 14 studies after doing elimination according to certain constraints in the literature. And 19 of these relationships were significant. All hypotheses were accepted.

7.1 Recommendations

In this study, it was revealed that study has moderate effect size. As study number increase or decrease, effect size would change. With increased convenient study number which include required statistics, results would be more significant according to meta-analysis. The more study or sample size means the more chance to obtain certain results.

Within the scope of this study, each meta-analysis studies taken from past, researched in software development sector. Meta-analysis studies would be also helpful to other sectors by conducting meta-analysis in different sectors or groups. As mentioned in previous sections, agile, agile methods and agile project management can be implementable and useful in different sectors or study areas.

Firms, organizations or groups would achieve project success by taking into consideration of examined and determined critical success factor which affects agile project management success in this study.

Lastly, researchers would be encouraged to share their studies in full texts on different data bases freely. It is crucial to obtain all descriptive statistics for each studies to conduct a meta-analysis. Researchers should give open access.





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