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A Systematic Literature Review on the Critical Factors that Contribute to Success of Agile Development Projects

Bachelor of Science Thesis Software Engineering and Management

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The purpose of this study is to identify the CSF (critical success factors) in agile software development and how these factors contribute to success in an agile project. The resulting thesis is created through conducting a Systematic Literature Review. It expands on the concepts of agile software development and the critical success factor that agile is deemed fit in accordance to its principles from the literature that has been reviewed.

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Abstract

Objective: The objective of this thesis is to identify the critcal success factors in an agile development projects.

Research Questions: Two research questions are addressed in this thesis. The questions are: "What factors define success in agile software development" and "How do these factors contribute to success of a project".

Methodology: In order to investigate and identify the critical success factors and their relating success attributes, a systematic literature review was conducted. 9 online journal database search engines were used to search for relevant research literature to this thesis, and 24 research studies were chosen. The studies were then filtered by using exclusion criteria. Then in each study, the relevant data was extracted by using keyword searches with keywords being related to the success factors and the success attributes. Finally, the findings were analyzed using frequency analysis to see which factors and attributes contribute to success. Since not many research studies have been conducted on this particular topic, the terminologies and naming conventions seemed tricky. To counter that, various synonyms and search criteria were used to retrieve an accurate result. In addition, detailed reading of some of the research studies were conducted to find additional keywords.

Results: In this thesis, it is reported that technical factors are addressed by the most number of papers to be the most important factor, followed by process, organizational, people, and finally project. Almost all the success attributes were addressed by some research studies, with the exception of 1 success attribute that was not addressed by any research study.

Conclusion: From the findings of this thesis, it can be concluded that with the exception of one success attribute, all the rest of the success factors and success attributes are relevant for project to success. This thesis provides an insight to the critical success factors and how the relating attributes are described in various projects. The critical success factors are still a relatively unexplored concept in the software engineering field, and further research on the concepts presented in this paper can help put them in practice in agile driven projects to achieve further success.

1. Main idea for the study

The purpose of this study is to identify the CSF (critical success factors) in agile software development and how these factors contribute to success in an agile project. The resulting thesis is created through conducting a systematic literature review. It expands on the concepts of agile software development and the critical success factor that agile is deemed fit in accordance to its principles from the literature that has been reviewed. For the purpose of the research, literature that has been written to indicate critical success factor, project success, and SPI (software process improvement) has been analyzed to identify the success factors and success attributes. From the list of literature, data has been extracted in form of success factors and success attributes, upon which a frequency analysis has been performed to see the findings from the various research studies. This thesis categorizes various success attributes from 5 different success factor groups and highlights the factors with their attributes in agile development projects. This study will contribute in spreading knowledge on how the

critical success factors affect the outcome of a project, and put focus on what is needed to improve the implementation of the success factors by analyzing the factors' role. Therefore, the resulting outcome from this thesis will help researchers and organizations see the importance of the success factors and the need to practice and tailor them for a successful outcome in an agile project. It will also allow other researchers to expand on the concepts of CSF in agile development process to study it further and help develop concrete methodologies of CSF that can be implemented in both theoretical and practical fields.

2. Background and Related Work

The definition of CSF is vague in software development area. According to Nasir and Sahibuddin [S1], not many formal studies have been conducted on CSF (critical success factors) in the agile software development project. As a result, different researchers refer to various "catalysts" to success as success factors, success dimensions, success criteria or success attributes. In this thesis, these "catalysts" are mentioned as success factors and their implementation methods as success attributes. It is interesting to see how the factors in agile manifesto can significantly improve the chances of a project to achieve success using its process. Traditionally, numerous studies have been conducted in the area of project management in order to define success. However, doing a constructive search on the literature databases, it shows that a few papers in the recent past have addressed the CSF in agile development projects. CSF in software project development is defined as issues that substantially increase the likelihood of a project to be successful [13], [14], [S1]. The general objective of this study will be to assess factors that define success in an agile development project. These factors have been derived from the conceptual factors and their related attributes presented by Misra et al. [RP 1], Chow and Cao [S 3], Sudhakar [SLR4], and Nasir and Sahibuddin [S 1].

2.1 Agile Methodology

Agile methodology is a set of development principles that were formulated in 1999 and introduced in 2001 [1]. Agile methodology's most important characteristic is the basis of iterations in the project lifeline. Each increment lasts a short period of time [2], though it may vary in different organizations. After each increment, a version of the product is released that is verified by the customer. More and more functionality is added to the development product, which is built from end-to-end [2] [4] [8].

Agile software development in general is characterized by the four attributes: *incremental, cooperative, straightforward, and adaptive* [1]. Incremental delivery is about small software releases in short development cycles. Cooperative means close and continuous collaboration between the customers and development teams. Straight forward implies that the method is easy to learn and to modify and that is sufficiently documented. Finally, adaptive means the ability to react to last moment changes. The agile manifesto has given rise to a number of agile methods including popular methods, such as, Extreme programming (XP), Scrum, Feature-driven development. Below is a short description of some of the popular Agile processes, chosen primarily on the frequency of the agile method used.

2.1.1 Scrum

Scrum, which deals particularly with how to manage tasks within a team-based development environment, is a management framework. The original term Scrum

comes from a study conducted by Takeuchi and Nonaka [5] in 1986. Jeff Sutherland further developed the Scrum process at Easel Corporation in 1993, by using the study of Takeuchi and Nonaka and unified the process as a whole [3].

Scrum has three basic roles within the framework: Product owner, Scrum Master and the Team [2]. The four basic phases in the process are planning, staging, development and release. It employs an iterative and incremental method that includes a set of predetermined practices and roles. The goal of the planning phase is to set vision and expectation of a project. In the staging phase requirements should be identified and priorities assigned for increment. The development phase involves a system implementation in increment with sprint plan. During the last phase the system gets deployed. The release and feedback from the customer after each sprint can thus make the increments successful. Sprints are flexible and use controls, risk management to avoid chaos simultaneously increasing flexibility [2]. Scrum methodology also increases transparency, within the team, organization, and the customer. This is achieved by practicing the following methods [4]:

- Daily standup meeting where each member of the development team says what they have done, what they will do, and what obstacles they have
- Keeping a dynamic Burndown chart, which states the progress of the current sprint, available for everyone to view
- Sprint review, demonstrating the deliverable the team has developed.
- Retrospective, where every member points out the pros and cons during the sprint. The cons will be fixed by the next sprint.

2.1.2 Kanban

Kanban is another framework developed in early 1940s as a method of the Toyota Production System [12], particularly focusing on visualization and signaling of work flow. Kanban's main focus is to match the volume of work in progress to the attributes to the team. Kanban allows for more flexible planning options, transparency in the development flow, makings tasks more visible and faster output [12]. The team strives for continuous delivery, instead of having hard milestones for delivery. Another attribute to Kanban is that the methodology doesn't have any existing roles for the development team [12].

2.1.3 Extreme Programming

XP is designed for small to medium teams. Some of the main characteristics of XP are short increments with small product releases and fast feedback, close customer collaboration, continuous refactoring, continuous integration and testing, collective code ownership, and pair programming [11]. In XP, the customer and the developers together determine the product functionality that will be developed in a series of increments, similar to Scrum.

In recent times more and more companies are turning towards agile development [4], particularly Scrum [4]. It has made an attempt to reduce the bureaucracy of the development processes, improve the quality, bring higher return on investment and minimize the time from the requirement to delivery commitment. One of the main goals in agile methodology is to increase productivity.

2.2 Critical Success Factors

Critical success factors in a software development process are the elements, attributes, and factors needed for an organization or project to ensure its success. Sudhakar [SLR4] defines critical success factors in an agile project as the parameters that affect the outcome of a project successfully while adapting the agile methodologies. As mentioned earlier, different naming conventions are used when referring to the critical success factors by different research studies. As a result, in this thesis the terminology used by Sudhakar [SLR4] is being used.

The success factors that have been focused in the recent studies are: organizational, technical, people, process and project [S3]. Since not many concrete results exist on the critical success factors on agile development projects, this thesis evaluates data from research studies expanding the analyzed CSF from various research studies that have different scale and scope. This thesis gathers perspective of the theories, methods, and process values from the literature mentioned in the tables (see Appendix C) and analyzes how they have been implemented in projects using agile software development processes.

3. Research Goal and Research Questions

3.1 Research Goal

The goal of this thesis is to identify the critical success factors in an agile project from various literature that has been analyzed, to see how the contributing attributes in the success factors lead the projects to success. The identification of these success factors and attributes will help future projects to tailor them into project setting and execution to lead the outcome in a successful manner.

3.2 Concrete task

The research questions this thesis attempts on addressing are:
RQ1: What factors define success in agile software development?
RQ2: How do these factors contribute to success of a project?

3.3 Resulting sub-tasks

In regards to RQ1, it is important to define the success factors that agile deems fit in accordance to its principles and subsequently in completion of a project successfully. This thesis examines various success factors, what causes these factors to lead a project to success, categorizes these factors into 5 different groups keeping in line with the agile manifesto, and what value it adds to various projects practicing agile development process. Subsequently, RQ2 will be analyzed as to how these success factors contribute to success.

In regards to RQ2, it is important to see what the attributes (relating back to RQ1) are, which must be practiced in a project to see their contribution to success. These attributes are from the organizational factor, people factor, technical factor, process factor and project factor that must be present in order to understand how they were contributing to success. The thesis looks at the practices and methods these success factors imply and how they are implemented according to the research studies. The factors that are analyzed are derived from agile methodologies and sets of potential

success attributes have been identified. This can relate back to RQ1 to see how these factors in given categories can contribute to the success in a given project.

4. Methodology

The research methodology implemented for this thesis is qualitative in nature. In order to perform a systematic literature review from the defined research question, correct set of literature was needed to be selected, filtered to meet the objective of the study, perform analysis to extract data, and analyze the extracted data for correct representation of the findings. The breakdown of the methodology is as follows:

- search the research studies to perform a systematic literature review
- define the validation of the literature (inclusion and exclusion of the literature)
- analysis of the selected research studies for the success attributes from the success factors
- analysis of the result by performing frequency analysis

4.1 Searching of the research studies

In this section, the method for searching for relevant literature is defined. Firstly, a number of online scientific journal search engines were used to find relevant studies. Then, from the number of studies, relevant literature was selected for further validation using the validation criteria mentioned in section 4.2. In order to find the relevant literature, it was necessary to address that not all published literature follow the standard terminologies for the proposed research topic. As a result, use of multiple synonym search strings were necessary. This resulted in multiple search strings to find relevant literature to the research topic. The literature was searched for using the following logical search strings without database specific expressions:

-Agile Methodology

- software AND processes OR software AND process AND agile OR software AND agile AND processes

-Critical Success Factors in Agile Developing Projects

- software AND process AND success OR software AND process AND success factor OR software AND process AND failure OR software AND process AND critical AND success AND factor OR software AND agile AND success AND recipe OR critical AND success AND factors AND attributes AND criteria OR agile AND process AND critical AND success AND factor

The online scientific journal search engines used to find the research studies can be found in Table 7 Appendix A.

4.2 Exclusion criteria of the research studies

31 research studies were extracted from many various studies found as a result of the search strings mentioned above. From the online databases mentioned in Table 7 (Appendix A), duplications present in two or more databases were discarded. Since it was difficult to read through all the studies that were found due to time constraints, from each online search 100 relevant titles (maximum) were read, since the key topic

words are diluted and go off topic as it proceeded. From that, 31 research studies were selected and for each of them the abstract was read and analyzed to see if it is relevant to the thesis. The quality assessment of the papers that were analyzed is listed below:

-Does it hold relevance to the field of computer science?
-Has the paper addressed the underlying question from the computer science field perspective?

-Does the paper hold relevance to RQ1?
-Keywords that were looked: agile; software processes, software projects, critical success factors

-Does the paper hold relevance to RQ2?
-Keywords looked at: critical success factors; agile; software processes, software projects, success

-Does the paper address critical success factor?
-Keywords that were looked: critical success factors, critical success factors in software development projects, success

-Does the paper address critical success factor in agile development projects?
-Keywords that were looked: critical success factors; critical success factors in agile software development projects.

-Does it categorize critical success factors into criteria?
-Keywords that were looked: critical success factors; critical success attributes; critical success criteria; critical success category; critical success dimensions; critical success definition

-Does the paper hold relevance to the year it was released?
-Filters that were used: 2001-2016, since studies published before 2001 will not hold much detail on Agile.

Addressing the quality assessment, 24 research studies were chosen to perform this systematic literature review. From the 24 research studies, 5 studies were selected at random and were read in detail, without any search key. This was done to verify the search terms and looking for additional keywords, which did not result in finding them. The randomly selected papers are: SLR4, SLR5, CS1, S3, and ES1.

The list of journals and conferences the research studies were retrieved from are:

- European Journal of Information Systems
- Software Engineering IEEE Transactions
- International Journal of Project Management
- Journal of Enterprise Information Management
- International Journal of Productivity and Performance Management
- Journal of Defense Software
- International review on computers and software
- International Journal of Computer Applications
- 37th Euromicro Conference on Software Engineering and Advanced Applications
- The Journal of Systems and Software
- Information and Software Technology
- Advances in Software Engineering and Knowledge
- Scientific Research and Essays

- Procedia Computer Science
- Computers in Human Behavior

4.3 Analysis of the selected research studies

4.3.1 Accepted Research Studies

After performing the validation of literature from the method described above, a list of 24 research studies were chosen to perform the systematic literature review. The papers (see Appendix C; Table 13-17) that are used for the literature review process are found in form of case studies and research theories on success or failure in agile implementation. The tables have been divided on the type of research the researchers have conducted their studies in. The tables have been split into 5 different tables: Table 13 consists of systematic literature reviews, Table 14 consists of Case studies, Table 15 consists of Surveys, Table 16 consists of empirical studies, and Table 17 consists of review papers.

4.3.2 Rejected Research Studies

Similarly to the accepted research studies section, a list of 7 research studies were rejected. The following sets of research studies were rejected from the review for the following reasons:

-It did not address success factors
-It addressed success but not the factors behind
-It addressed other software process development other than agile or implementation of agile
-It is outdated

The rejected paper may still be used in the thesis for conceptual information or background referencing, though they will not be used for the reviewing process. See Appendix C Table 18 for a detailed information of the papers.

4.4 Searching of the relevant topic from the selected literature

The criteria for selection of these papers were their validity in addressing the concepts of success, failure and improvements in agile methodologies from empirical studies, survey studies, literature review, review study. The type of study conducted is not a filtering factor, since this thesis aims to analyze any kind of research done for CSF on agile software development projects.

Each article was analyzed by using search string derived from each success factor and their contributing success attributes. The success factors and the success attributes were derived from the concepts proposed by Ahimbisibwe et al. [SLR3], Sudhakar [SLR4], Misra et al. [RP1], Nasir and Sahibuddin [S1], and Chow et al. [S3]. Key words and synonyms were used from each success factor and success attributes in the search string. In each of the research article the following search strings were used:

Organizational:

- Customer AND commitment
- Clear AND flexible AND planning; flexible AND planning; clear AND planning
- Well AND defined AND scope; well-defined AND scope
- Progress AND tracking; progress
- Decision AND time; decision
- Team AND distribution
- Planning AND control

Technical

- Clearly AND defined AND requirement
- Documentation AND system AND procedure
- Tested AND software; testing AND software; testing; verification; validation
- Tools; necessary AND tools; supporting AND tools

People

- Competency AND level; competency; skill
- Motivated AND individuals; motivated AND staff
- Communication AND team; negotiation AND team; communication AND customer; negotiation AND customer; communication AND staff; communication AND staff AND customer
- Technically AND expert; technically AND experienced; agile AND experts; agile AND experienced
- Training AND needs; learning AND needs
- Meeting; meeting AND day-to-day AND basis; day-to-day
- Defined AND work AND hours; work AND hours
- Customer AND presence
- Customer AND authority

Project

- Non-life-critical; non-life-critical AND project AND nature; life-critical; life AND critical; system AND critical; safety AND critical
- Dynamic AND schedule; delivery AND milestone; Dynamic AND schedule AND delivery AND milestone
- Cost AND evaluation; cost; cost AND estimation; cost AND control; budget AND estimate; budget
- Risk AND analysis

4.5 Analysis of the result using Frequency Analysis

4.5.1 Extraction of the data

Using the search string mentioned above, the relevant topic was analyzed meticulously. As soon as the factor has been addressed, and explained, it was classified as indicator *Y* for the specific success attribute in a given paper (see Appendix B). If it was not addressed then it was classified as indicator *N.* Appendix B consists of the data extracted from 24 research studies. The number of indicator *Y* was counted for and has been used to see how many research studies addressed a specific factor. The success attributes have been divided into five tables, with each table representing a success factor (see Section 5.2).

4.5.2 Frequency Analysis

The success factors and the attributes are put against the research studies (see Table 8-12 in Appendix B*)* and has been analyzed to see if the research studies address the success factor and the attribute or not. The analysis has been made on the frequency

of the success attributes that are addressed in the papers. The equation for the frequency analysis used for this thesis is:

*success attribute * 100 / 24 = Frequency (in percentage)*

This equation has been used in the analysis section to give a perspective of the findings and to understand which success factors and attributes contribute most to success.

5. Results

5.1 Data Extraction

In the list below, the success factors extracted from the 24 research studies has been listed. 5 success factors, along with 24 success attributes have been formulated from the concepts presented by Ahimbisibwe et al. [SLR3], Sudhakar [SLR4], Misra et al. [RP1], Nasir and Sahibuddin [S1], and Chow et al. [S3]. In this thesis, the attributes are divided into the five different factors and are against the mentioned literature (see Appendix B for more detailed data extraction).

5.1.1 Organizational

The organizational success factors take the agile manifesto into context and highlights some of the most important attributes such as *customer commitment*, *decision time*, *clear and flexible planning*, *a well-defined scope*, *progress tracking*, *decision time*, and *planning and control* [S3, S4, SLR1, SLR, SLR4, CS1, ES1]. The agile manifesto adds weight on customer collaboration, stating that highest priority should be given to achieving customer satisfaction, and this is done by early and continuous delivery to the customer, which requires the customer to be in constant contact with the agile team [S3, S4, SLR1, SLR, SLR4, CS1, and ES1]. Customer collaboration also allows for the team to plan the continuous delivery with the customer, thus making *decision time* more clear and consensual [RP1, S3]. *Clear and flexible planning* between the team and organization allows for transparency within the organization, which will be visible in prioritizing work accordingly, leading to achieving in clear focus [RP1]. *A well-defined scope* accordingly allows for planning of the project (within team and with customer) to be simpler and within various parameters (budget, time) [SLR4, S1]. *Clear distribution of the team* in a project is described as a well-organized, centralized, local team that allows for the progress to success by not being affected by cultural or political matters [SLR3]. Through *planning and control*, internalized plans and qualitative control has been portrayed as a successful ingredient for organizations practicing agile practices [RP1].

5.1.2 Technical

The technical success factor is essential for success for any project team using agile, and in this thesis the attributes *clearly defined requirement*s, *documentation of system and procedures*, *properly tested software* and *supporting tools* for the team to use are highlighted. Change in requirement is expected and welcomed in agile development [SLR3, S1, and RP1]. Clear requirements help having clear vision of what the customer expects the product to be, and clarifying the requirement helps in achieving bring customer's expectation closer, validating the product in the process [S3, CS1,

and RP1]. *Documentation of system and procedures* enables users to achieve technical information about the work and the product being developed [S3, CS2]. *Properly tested software* allows for delivering the right product [RP1, S1]. *Supporting tools* allows for team members to execute their work more efficiently [S1].

5.1.3 People

The people factor is very important for agile development projects. It puts focus on the team, and what is needed to make them most productive while not being overworked [SL3, S3, S1, and SLR4]. *Well-defined competency* level allows the management to put the right people for the right job in the project, while if the requirements for the person's competence are not met, *training and learning needs* can always be addressed [CS1, RP1, S1, S3]. The teams need to have a *clear and balanced composition* of being technically expert, technically experienced, at the same time being agile experts and agile experienced. This enables support to be available within the team whenever needed [SLR3, SLR7, S3, SLR4, RP1]. The team needs to have *motivated individuals* to allow for decision making, fault searching, and addressing change if needed [CS4].

5.1.4 Process

Agile manifesto states that process is a key factor in achieving success in a project. Agile is a flexible methodology and believes in *communication*, *transparency*, *clearly defined work per task*, *customer presence* and *customer given full authority* [RP1, CS5]. In agile teams usually *meet day to day basis* and discuss the work [ES1, CS5]. The teams decides and gives clear tasks and a *definition of time* to themselves per task [RP1, ES2]. Customers are usually involved in agile product to enable the right product is being made and the customer as a result is also given *full authority* [RP1].

5.1.5 Project

In order for a project to be successful, it needs to have *set delivery milestones* such as end of sprint demo, but could consist of dynamic schedule [S3]. The project should *lay cost evaluation up front* [S3] [CS4]. According to a hypothesis set by Chow and Cao [S3] an agile project needs to be *non-life critical*, though no evidence of this was found in the rest of the research studies.

5.2 Result

This section has been divided into five success factors, showing the number of research studies pointed out the success attributes that lead to success in an agile project. The five sets of data (see Appendix B) are divided into Organizational factor, Technical factor, People factor, Process factor, and Project factor.

5.2.1 Organizational Factor:

Figure 1 Organizational Factor and Success Attributes

In Figure 1, the success attributes from the organizational factor are analyzed in the 24 research studies. Here it is visible that from the organizational factor, *customer commitment*, *planning and control*, and *clear and flexible planning* were thought to be vital for a project to be successful. In Table 1 it shows that *customer commitment* was mentioned by 95.8% of the research studies, *planning and control* was mentioned by 91.7%, and *clear and flexible planning* was mentioned by 83.3%. However, *decision time*, *team distribution*, and *progress tracking* were addressed by a lower percentage of the researcher papers, with *decision time* being addressed by 70.8%, *team distribution* being addressed by 66.7%, and *progress tracking* being addressed by 58.3% of the research studies.

Success Attribute	Frequency	Percentage
Customer Commitment	23	95.8
Planning and Control	22	91.7
Clear and Flexible Planning	20	83.3
A well-defined Scope	18	75
Decision Time	17	70.8
Team Distribution	16	66.7
Progress Tracking	14	58.3

Table 1 Frequency Table for Organizational Factor

5.2.2 Technical Factor

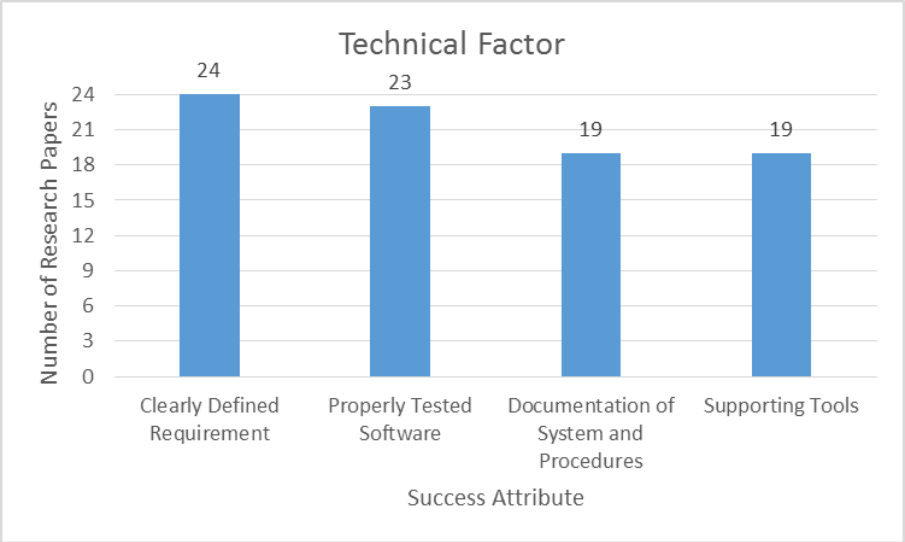

Figure 2 Technical Factor and Success Attributes

In Figure 2, the success attributes from the technical factor are analyzed. Overall, it is seen that researchers believe technical factor is essential. In Table 2, it is visible that *clearly defined requirement*s is seen as an absolute important attribute to achieving success, with 100% of the research studies mentioning its need. *Properly tested software* is also seen is very important, with 95.8% of the research studies analyzing it. *Documentation of system and procedures* and *supporting tools* was seen quite importantly as well, with 79.2% of research studies mentioning them as a key ingredient to success.

Success Attribute	Frequency	Percentage
Clearly Defined Requirement	24	100
Properly Tested Software	23	95.8
Documentation of System and Procedures	19	79.2
Supporting Tools	19	79.2

Table 2 Frequency Table for Technical Factor

5.2.3 People Factor

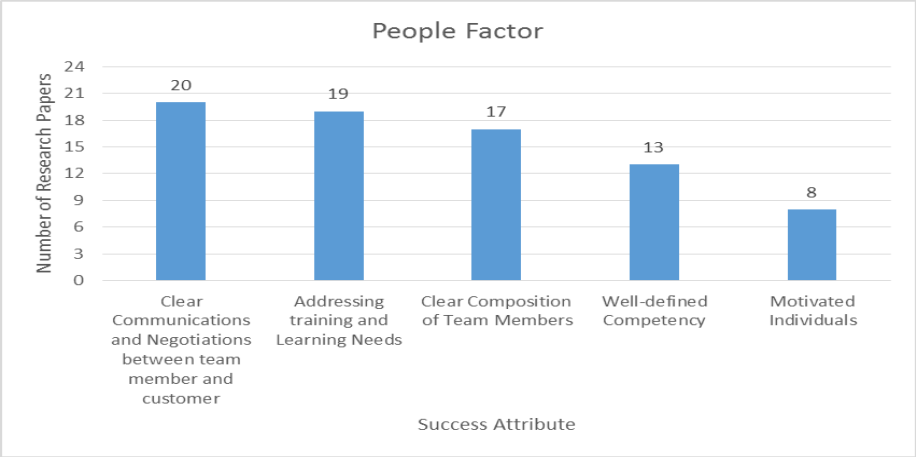

Figure 3 People Factor and Success Attributes

In Figure 3, the success attributes from the people factor is analyzed. In Table 3 it is visible that overall less research studies addressed it. *Clear communications between team member and customer* was addressed the most, with 83.3%. *Addressing training and learning needs* was also relatively high, with 79.2% of the research studies believing it is crucial. *Well-defined competency* and *motivated individuals* were not seen to be as vital, since not that many research studies elaborated on them. *Well-defined competency* was found in 54.2% of the research studies, where *motivated individuals* was found in 33.3% of the papers.

Success Attribute	Frequency	Percentage
Clear Communications and Negotiations between team member and customer	20	83.3
Addressing training and Learning Needs	19	79.2
Clear Composition of Team Members	17	70.8
Well-defined Competency	13	54.2
Motivated Individuals	8	33.3

Table 3 Frequency Table for People Factor

5.2.4 Process Factor

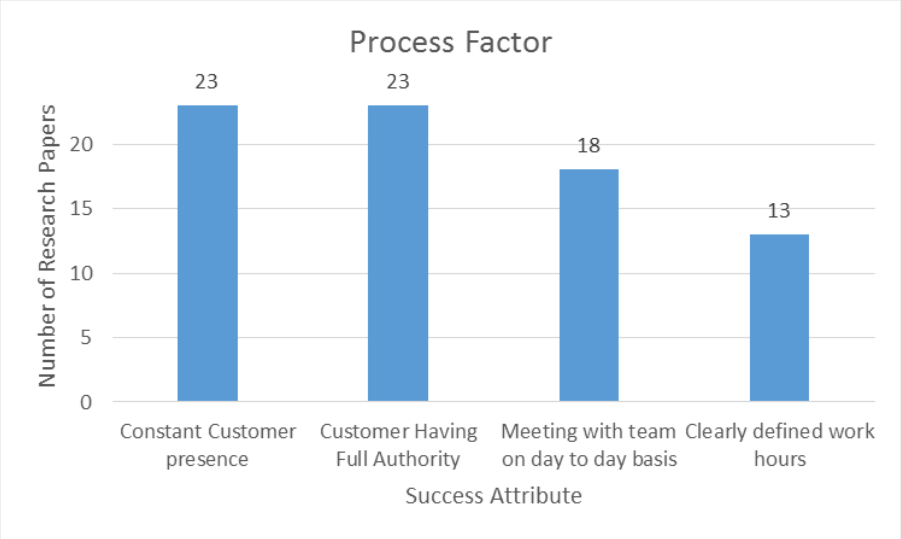

Figure 4 Process Factor and Success Attributes

In Figure 4, the success attribute in the process factor have been also been perceived to be important in the research studies. The focus here is on customer related success attributes. In Table 4 it is visible that 95.83% of the research studies believe that *constant customer presence* and *customer having full authority* is vital for success. 75% of the research studies agree that *meeting with team* on day to day basis is important too. However, only 54.2% of the papers agreed that *clearly defined work hours* will lead to success.

Success Attribute	Frequency	Percentage
Constant Customer presence	23	95.83
Customer Having Full Authority	23	95.83
Meeting with team on day to day basis	18	75
Clearly defined work hours	13	54.2

Table 4 Frequency Table for Process Factor

5.2.5 Project Factor

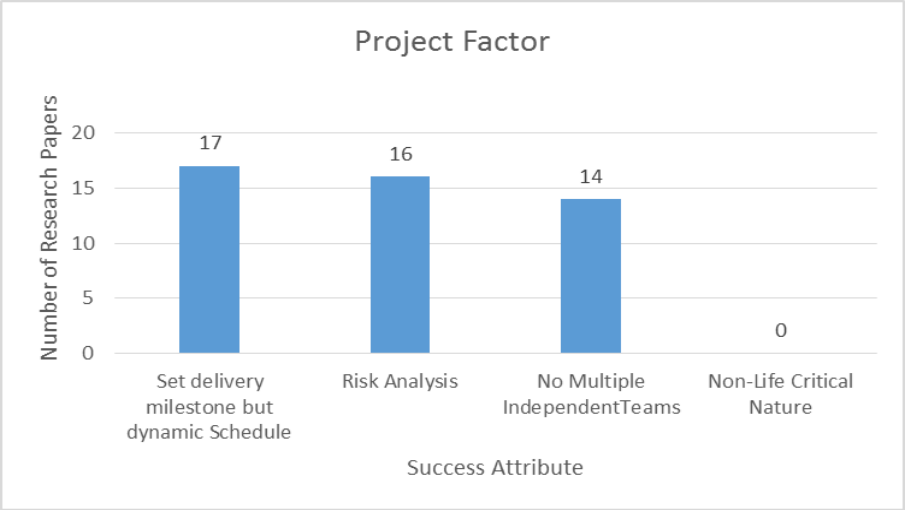

Figure 5 Project Factor and Success Attributes

In Figure 5 the success attributes from the project factor is analyzed, and it is visible there that a lower percentile of research studies addressed them. In Table 5, *set delivery milestone but dynamic schedule* is shown to be the most frequently used success attribute, with 70.83% of the research studies believe it to be crucial for the project to achieve success. *Risk analysis* was elaborated by 66.7% of the research studies. *Cost evaluation up front* was discussed by 58.3% of the research studies. *Non-life critical nature* of a project was not addressed by any of the papers. *Non-life critical nature* was addressed as a hypothesis in one of the research studies [S3], however even in that paper no evidence was found of it being a critical success attribute.

Success Attribute	Frequency	Percentage
Set delivery milestone but dynamic Schedule	17	70.83
Risk Analysis	16	66.7
Cost evaluation up front	14	58.3
Non-Life Critical Nature	0	0

Table 5 Frequency Table for Project Factor

6. Discussion and Findings Analysis

From the results, it shows that several studies have shown the importance of the success factors and success attributes in agile project success. To evaluate their connections and relation to the research question, an analytical approach has been taken in the following sections. In Section 6.1, a rearrangement of the success attribute has been proposed by introducing new success dimensions. In section 6.2, the research questions have been answered in detail from the findings of the result.

6.1 Taxonomy

In Figure 6, a logical connection between the set of attributes where they seem to be complimenting each other into achieving success through dependencies have been extracted. This is an analysis performed with information used from the methodology

and results. Here, the attributes that were found most in relation to each other are connected, as a result a few attributes from the result are not added. The solid lined boxes are the attributes. The solid lines are a connection between the attributes and their dependencies. The white boxes the sets of synonyms that were used into searching for the specific attributes, where the terminology seemed insufficient. The sets of attributes have been divided into 4 groups: scope dimension, tools dimension, customer dimension, and team dimension.

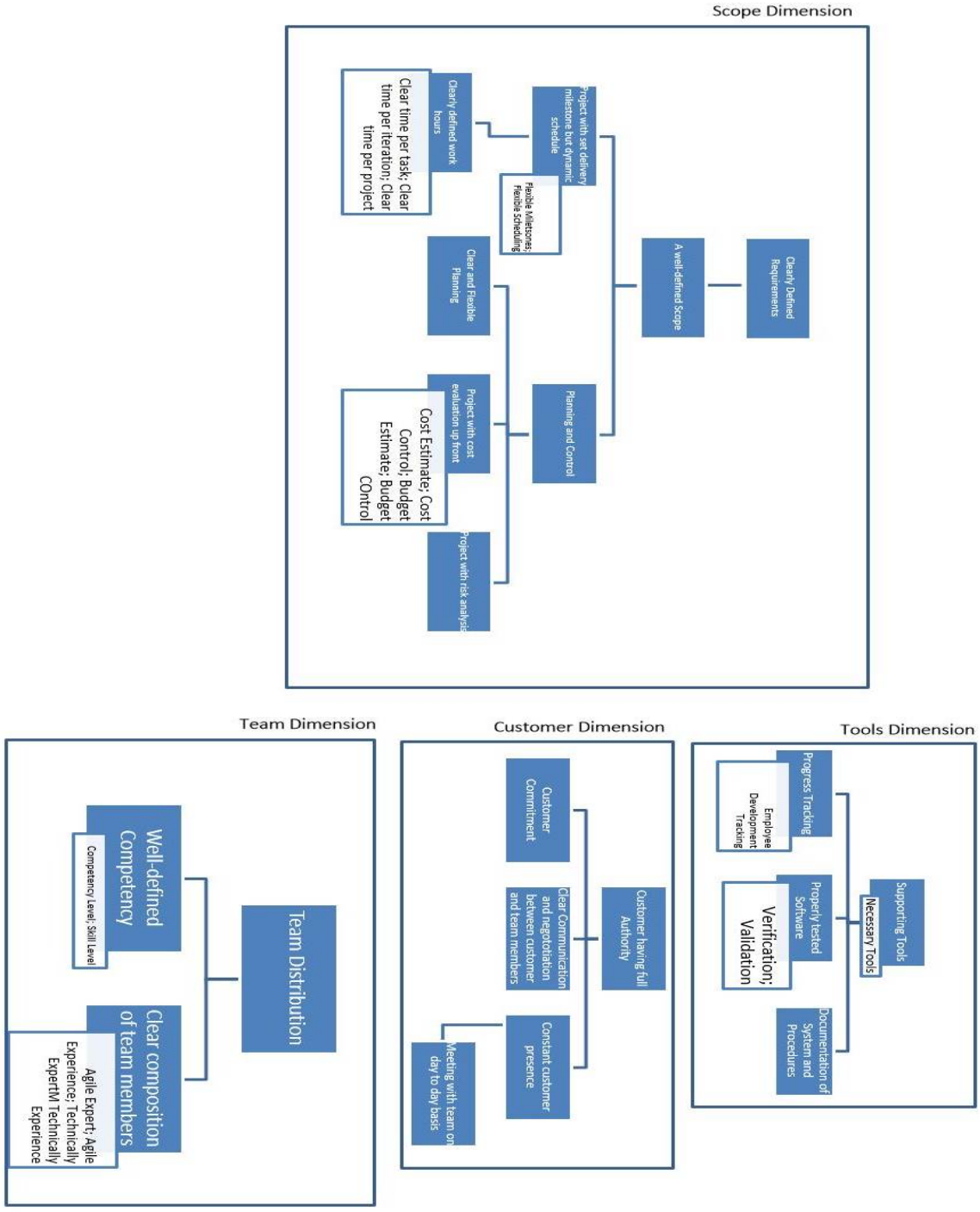

Figure 6 Taxonomy of the Attributes and relationship to each other

In the scope dimension, Aziz and Wong [S2] stated that implementing *clear and precise requirement* related tasks help *define the scope* and complete the project within the set criteria. *The scope* plays an important part in *proper planning and control*, and *delivery milestones*, as mentioned by Drury et al. [CS3]. From the *set delivery milestone*, *dynamic schedule* can be extracted [SLR6], which can *clearly define the hours* [SLR6] for the task and the iteration. From *proper planning and control*, *clear and flexible planning, cost evaluation,* and *risk analysis* can be made that can avoid failures and lead the project to success [SLR6]. In order to implement a more broad area of search, for *delivery milestone, fixed milestone* and *flexible scheduling* synonyms were used. For *clearly defined work hours*, *clear time per task per iteration per project* synonyms were used. For *project with cost evaluation up front, cost estimate, cost control, budget estimate, and budget control* synonyms were used.

In the tools dimension, Jones [SLR6] mentions that project management tools helped in tracking schedule and progress of individual workers. Therefore, I have stated in Figure 7 that *supporting tools* can aid in *progress tracking.* Unterkalmsteiner [SLR1] mention that appropriate tools can aid in the support of proper software engineering practices such as *properly testing of software, and proper documentation of system and procedures.* The tools can be defined in the beginning of the project, and also be easy to use. In order to perform a broader area of search, for *supporting tools*, the synonym *necessary tools* was used. For *progress tracking,* the synonym *employee development tracking* was used. Lastly, for *properly tested software,* the synonyms *verification* and *validation* were used.

In the customer dimension, Ahimbisibwe et al. [SLR3] have mentioned customers to be a unique factor for achieving success. It is mentioned that customer participation, support, and customer client experience to be important attributes. As a result, I interpret that *customer having full authority* can lead to *clear communication and negotiation between the team members and customer*, can enable the customer to be *constantly present* at the development site, and can enable *customer commitment* to be greater. Here, the concepts were quite clear, as a result no further synonyms were used.

In the team dimension, Sudhakar [SLR4] mention the importance and impact of proper *team distribution* can have on an outcome of a project. He used the example of organizations going for global software development, and how important it is to globally distribute the team and the need for cooperation culturally diversified teams. This can lead to *clear composition of team members* and help form team members with *well-defined competency.* In doing so, a competent/diverse team can be extracted that can work in a group that contribute to success by complimenting each other. In order to perform a broader area of search, for *well-defined* competency, *competency level* and *skill level* synonyms were used. For *clear composition of team members*, *agile expert, agile experience, technically expert* and *technically experienced* were used.

In Table 19 in Appendix D, the list of attributes from the success factors have been extracted and put them against the new proposed dimensions. These dimensions can be further elaborated with further attributes to form factors on their own.

6.2 Answer to Research Questions

The total number of attributes identified as important success attributes is 24, arranged in 5 factors. In each factor, there are varying success attributes that each research study has identified. The summary of all the success attributes from the literature review is listed in Figure 7.

Based on the outcome of the frequency analysis for each success factor in the 5 success factors, the research questions can now be answered. These answers are based on the findings from this systematic literature review.

6.2.1 Research Question 1

The first research question was "What factors define success in agile software development?" Based on the findings from this thesis, it was found that a high percentage of research studies referred to all (technical (88.5%) process (80.2%), organizational (77.4%) people (64.2%) and project (48.9%)) the factors as determinant success factors in an agile development project.

Success Factor	Percentage
Technical	88.5
Process	80.2
Organizational	77.4
People	64.2
Project	48.9

Table 6 Average percentage of each success factor

The average number of research studies addressed technical factor as the most important factor (88.5%) with the success factors as being most vital to an agile project. According to Chow and Cao [S3], the technical factor is most critical in impacting the success of an agile project, as it covered more of methodologies of working, tools, and documentation from Agile Software Engineering techniques [6]. According to Drury et al.'s [CS3] research studies, in order to increase project success the customer would attend the daily stand-up meeting to increase the technical knowledge in a team.

Process factor in this thesis also emphasized on the need of customer collaboration. Here, *constant customer presence*, and *customer having full authority* attributes were addressed by 95.83% of the research studies. The process factor was identified by second most number of research studies (80.2%). As mentioned earlier, in a case study conducted by Drury et al. [CS3], the customer would be present in the daily stand-up meeting to see to the team's technical need, and to refine requirements [CS3], enabling the process to be strengthened leading to success.

Organizational factor had a wider range of success attributes that were addressed by the research studies. While *customer commitment* were addressed heavily by 95.8% of the research studies, *progress tracking* was addressed by 58.3%. On average however, the organizational factor was addressed by 77.4% of the research studies. Lee et al. [ES1] mention that organizational culture is a critical factor for effective knowledge sharing, employee commitment, management transparency and it can be achieved by top management support that can implement the organizational factors as a practice.

People factor was addressed by a relatively lower percentage of the research studies (64.2%). The people factor had varying references to the research studies. Though *clear communications and negotiations between team member and customer* (83.3%) and *addressing training and learning needs (79.2%)* were relatively high, *well-defined competency (54.2%)* and *motivated individuals (33.3%)* were quite low, relatively.

Project factors was answered by the least number of research studies (48.9%). *Set delivery milestone (70.8%), risk analysis (66.7%), cost evaluation up front (58.3%)* attributes were discussed by at least half the research studies. However, *non-life critical nature* of the project was not addressed by any paper to be a contributing attribute, bringing the total for project factors to 48.9 percent.

From the above analysis, it can be derived that technical, process, organization and people factors are essential success factors, since on average more than half (ranging from 88.5% to 64.2%) the research studies addressed them as being required for a successful outcome of an agile project. Project factor too is considered to be successful in this report, since out of all the attributes, only 1 attribute resulted back in 0 findings. In other words, failure to identify 1 success attribute in a success factor should not be judged as a non-contributing factor to success.

6.2.2 Research Questions 2

The second research question was "How do these factors contribute to success of a project?" Here, the success attribute for the factors will be analyzed. All the success factors were addressed by at least a third of the research studies. In the case of success attributes, the findings resulting in varying numbers.

Technical factor is achieved in this thesis with *clearly defined requirements* (100%), *properly tested software* (95.8%), *clear documentation of systems and procedures* and *supporting tools (79.2%)* attributes. The technical factors consisted of the only success attribute (*clearly defined requirement*) that every research studies addressed (100%). Aziz and Wong [2] state that "a key reason for project failures is insufficient management of changing requirements during all stages of project life cycle". *Clearly defined requirement*s avert failure, help keep the validity of the developing product, and vision for the outcome right [S3, S2, and RP1]. Sahibuddin et al. [S1] mentions that in his research most practitioners considered clear requirements and specifications to be the most important part of critical success factors. Implementing clearly defined requirements from the beginning of the project could keep the vision and scope of the project in proper path for both the customer and the development team. Osario et al. [CS2] states that an iterative software development imposes iterative testing, which increases the product quality. Using inappropriate technology and tools not conforming to the project tend to lead towards project failure, mentioned by Tanner et al. [SLR9], where a case study was performed to shift from traditional process to agile process. Technical factor as a result is accomplished by *clearly defining requirements* [CS1, CS3, and ES1], *properly tested software* [SLR9, CS2], *clearly defining documentation of systems and procedures*, and *providing proper supporting tools* [S3].

Process factor is achieved in this thesis with *constant customer presence (95.8%), customer having full authority (95.8%), meeting with team on a day to day basis*

(75%) and *clearly defined work hours (54.2%).* In the process factor, it was `seen that 95.8% of the research studies believe it to be a defining method into achieving success. *Meeting on day to day basis* was supported by papers who were describing Scrum and saw it to be a good practice to achieving success. In a survey conducted by Hummel et al. [S5], it was evident that the involvement from the customer is crucial. The customer was involved in providing concrete feedback to validate the final product, attended in daily meetings with the development team, and the team tended to customer satisfaction. Establishing a customer oriented project with regular meetings can enable the project to reach its goal from the outset of the project. *Clearly defined work hours* was not perceived by many as a means to achieving success. However, 54.2% of the research studies thought it was an important attribute in achieving success. The process factor as a result is accomplished by *constant customer presence*, *customer having full authority*, *meeting with team on a day to day basis*, and *having a clearly defined work hours* [S3].

Organizational factor is achieved in this thesis with *customer commitment (95.8%), planning and control (91.7%), clear and flexible planning (83.3%), a well-defined scope (75%), decision time (70.8%), team distribution (66.7%), and progress tracking (58.3%).* It is visible that most of the research studies defined *customer commitment* as an essential ingredient in achieving success. *Planning and control* (91.7%) here is referred to as internalized plans and qualitative control, which helps the team realize the tasks and work more clearly [RP1]. *Clear and flexible planning* here is referred to as the planning between the team and organization that allows for transparency visible prioritization of work, which in turn helps the customer understand the organization's methods [RP1]. According to Hummel et al. [S5] the management needs to create an environment to allow the employees to make the right decision, and this in turn helps them make decisions correctly. To summarize, the organizational success factor is achieved through *customer commitment*, *planning and control*, *clear and flexible planning*, *a well-defined scope*, efficient *decision time*, proper *team distribution*, and *progress tracking*.

People factor is achieved in this thesis by having *clear communication and negotiation between team members and customer (83.3%), addressing training and learning needs (79.2%), clear composition of team members (70.8%), and well-defined competency (54.2%).* Hummel et al. [S5] states that to have a clear communication and transparency between the customer and the team, the customer used Kanban boards to see the current status of the project. This was a successful implementation in the procedure of the project, where the team and the customer clearly could have dialogues based on the current status. Based on the results, tailoring clear dialogue between the customer and the team in a project is beneficial in project success. Hummel et al. [S5] also state in their survey that team members mentioned the need of a clear composition of the team members, since "it gets difficult to control 30 different people with 30 different opinions". This could be a harming factor towards success. *Motivated individuals (33.3%)* was addressed by less than half the research studies as an attribute that contributes to the success factor. However, Sulayman et al. [CS4] mentions that necessary steps must be taken to motivate employees to ensure proper development of the product. Motivated individuals will provide the team with correct decision making, fault searching, and in turn create a quality product that tends to customer needs. There could be various

reasons why the findings in the other research studies for *motivated individuals* was relatively low, and this is discussed in the subsequent sections (see Section 7).

Referring to RQ1, the project factor is the only factor to be addressed by less than half the research studies as a contributing factor to success in this thesis. However, the project factor success attributes in this thesis was *set delivery milestone but dynamic schedule,* addressed by 70.83% of the research studies*, risk analysis,* addressed by 66.7% of the research studies*,* and *cost evaluation up front,* addressed by 58.3% of the research studies*. Non-life critical nature (0.0%)* was not addressed by a single paper as part of success contributing attribute. Having one success attribute not contributing out of the rest of the attributes in the project factor should not classify project factor as non-contributing to success. The rest of the attributes were considered to be contributing to success by the research studies less frequently compared to the other the attributes in the other factors. Though Cao and Chow [S3] didn't find any successful result for *non-life critical nature of a project* either in their paper, it was hoped that the findings in this thesis would result differently.

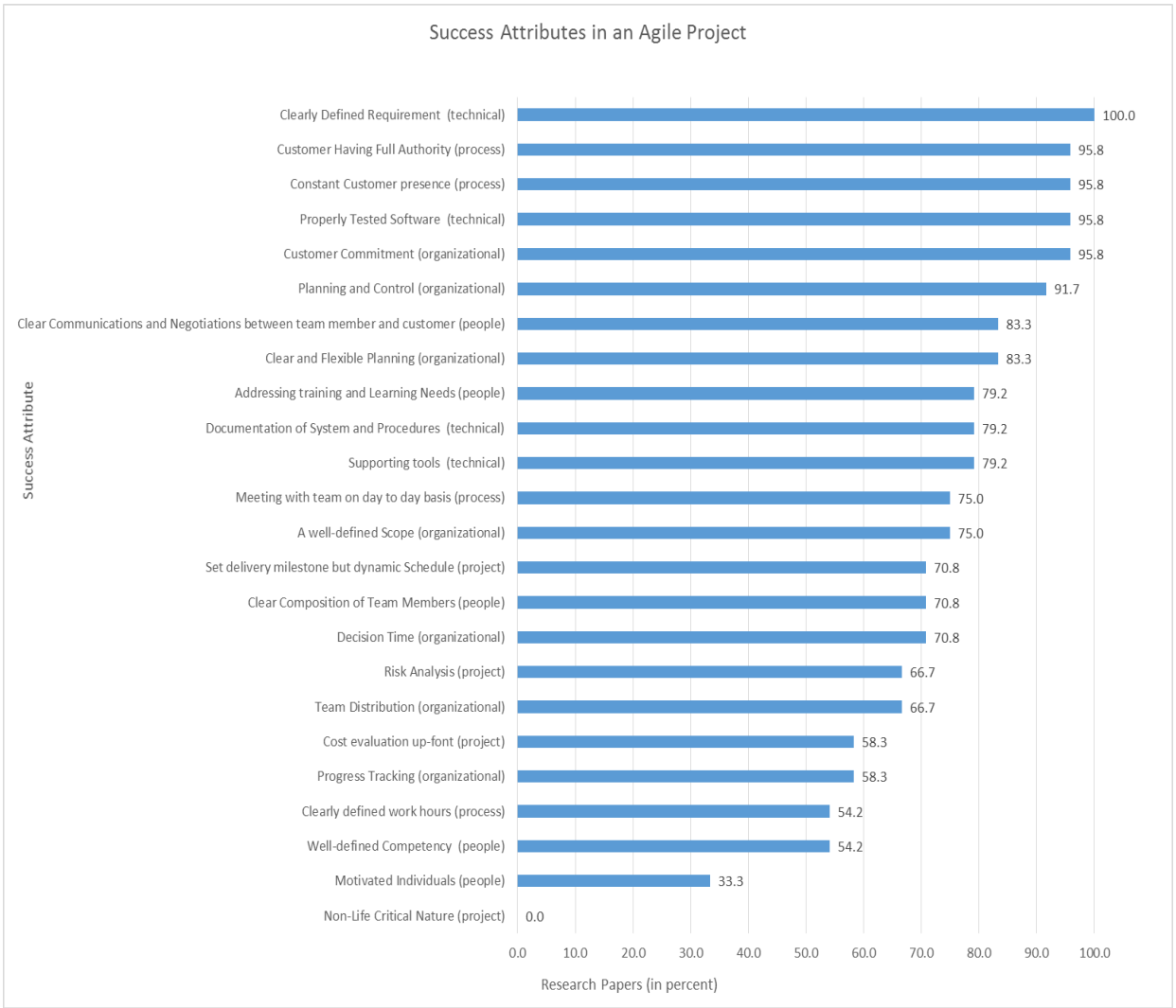

Figure 7 Success attributes in Agile projects

7. Research Limitation

In spite of the choice of validated research studies and research methodology, there are limitations in this thesis. The first limitation is the possible bias towards the concepts of success factors. The second limitation is the interpretation of the theories stated in the research studies. The third limitation is the theoretical validity in the research studies. The fourth limitation is the generalization of the theories presented in this thesis through the analyzed research studies. In order to address them, the research methodology was extensively executed by having various criteria into choosing the correct literature, choosing the correct concepts from the literature, and extracting the result accordingly.

Threats to Validity

Bias in literature

Considering that this is not a comparative study, a bias can occur. Here, while choosing the literature, the research studies were searched with strings that conformed to conceptual words such as *success, factors,* and *agile* (see page 6). This gave search hits to research that already support the concepts of how different factors contribute to success. Also, the research studies themselves could be bias towards agile's tendency to produce successful projects to further promote the methodology, and the lack of non-agile papers could confirm that notion. The researcher could have been biased towards her preconception about the research topic, which could tend to lean more towards the topic question.

Interpretive Validity

The analysis performed in this thesis could have been interpreted differently from what the analyzed research studies state. This can be seen in the search string for finding each concept of success factors and attributes in each research studies (see page 14). There, it is stated that after searching for the key concept, it would be analyzed further. Differences in naming conventions, while the source concept was similar to the search, could lead the result in a different direction. To avoid this mishap, the search strings had various synonyms to each concept (such as people vs staff). In addition, five research studies were selected at random and thoroughly read to verify the search terms and find any additional keywords, which did not result in any new search word. A large number of research studies analyzed in this thesis are case studies and surveys. Here, the researcher interpretation of the data could be subject to distortion or wrong description due to various reasons such as cultural, geographical, and linguistic reasons. As mentioned earlier, critical success factors for software development projects have not been conceptualized, and is subject to subjective interpretation.

Theoretical Validity

Though the agile principles have been conceptualized in the agile manifesto [3], the concepts of critical success factors in software development or agile development have not been conceptualized. This research as a result has combined various success factors and related success attributes from the concepts that agile principles can be related to. This provides a threat to theoretical validity, where the concepts are perspectives that the researchers provide through their research. Though many supporting proofs have been found, these theories are still to be conceptualized. For example, in this thesis *project factor* is not seen as important of a factor that

contributes to success in compared to the other factors, due to *non-life critical* attribute not being addressed by any research studies. However, the other attributes in relating to project factor have been addressed by more than half the research studies. This thesis, as a result does not consider *project factor* to be an unimportant factor, and the results might have been different had a larger number of research studies been analyzed. This will, as a result, decrease the theoretical validity of *project factor.* Also, having analyzed all the papers, it is evident that there is a problem in naming convention between the success factors, and success attributes. Chow and Cao [S3], and Tanner et al. [SLR9] among some other researchers mention the factors as success dimensions whereas in this thesis it is mentioned as success factors and similarly what this thesis states as success attributes was mentioned as success factors. However, in this thesis the approach by Ahimbisibwe [SLR3], Misra et al. [RP1], Nasehi [S4] have been implemented, who mention the success factors and attributes.

Generalization

This thesis is conducted by analyzing 31 (24 accepted, 7 rejected) research studies. It is considerably low in scope, since many key success factors that exist may have been missed. The objective of this research was to analyze most of the relevant research studies that exist on critical success factors in an agile development project, though it was not possible. A smaller number of papers have been analyzed compared to the large existing agile community. This thesis did not expand on all the methods of agile development. The research studies mostly mentioned Extreme Programming, Kanban, and Scrum methodologies. However, a bigger generalization is been made from the small findings. Though the findings are evident from the result, it is still subject to generalization.

Search Engine

From each online database search engines, 100 research studies (maximum) were read. This was done since further papers decreased in relevance, consisting of few keywords. However, different databases had different behaviors and are unable to provide a reliable ranking of papers by relevance. As a result, threat to missing relevant studies could be prominent. To counter this, more than 100 relevant research studies could be read. Another method could be to read a few papers at the end of the search result to see how irrelevant they are to the search to make a logical judgement into justifying the choice of a specific number of papers.

8. Conclusion

In this thesis, I have tried to identify the critical success factors and their contributing success attributes by performing a systematic literature review from a set of literature (24 accepted, 7 rejected). These success factors and attributes are derived from conceptual topics addressed in the agile principles. The data was collected by performing a systematic literature review and then formed a set of 5 success factors and 24 success attributes collected from various literature. Consequently, these success factors and success attributes were identified in other analyzed research studies (24 research studies) and a frequency analysis was done on the data extracted.

From the results, it is reported that out of the success factors, technical factors are the most contributing factor to success in an agile development project, followed by process factors, organizational factors, people factors and lastly project factors. From

the set of contributing success attributes in each success factor, *clearly defined requirements* (technical), *customer having full authority* (process), *constant customer presence* (process), *properly tested software* (technical), *customer commitment* (organizational) and *planning and control* (organizational) were identified by most research studies as an important catalyst to success. *Cost evaluation up front* (project), *progress tracking* (organizational), *clearly defined works hours* (process), *well-defined competency* (people), *motivated individuals* (people), and *non-life critical nature* (project) were identified by relatively low number of research studies.

Out of all the success factors and success attributes, only *non-life critical nature* of a project was not identified by any of the research studies that I have analyzed, as a result, only this success attribute is a non-contributing success attribute. To counter the zero findings, synonyms were used to find this particular attribute (as previously mentioned in section 7) but it continuously resulted in zero findings. However, the rest of the success factors and success attributes were identified, addressed, and elaborated by various research studies as contributing factors to success, if implemented in an agile project.

From the findings of this thesis, I can conclude that with the exception of *non-life critical nature* of a project, the success factors and attributes presented can be used to be implemented in an agile project to lead to a more successful outcome. A possibility to conduct a broader research covering more aspects of organizations practicing other agile methodologies can be performed in the future. Subsequently, these success factors need to be conceptualized to be practiced as methods, not just principles. A set of new success dimensions were proposed in section 6.1, where the list of existing attributes were regrouped into hierarchical dependencies and shows how each attribute can lead to the implementation of the next one in a convenient manner. However, for this empirical data is needed. This paper has addressed a set of success factors and attributes and these can form a framework for more concrete data to be collected. The success factors and attributes in many ways are interlinked with each other, which can be a possibility to further analyze and perform research to see their interrelation and create a conceptual model based on the findings.

Critical success factors are still a relatively unexplored territory in the software industry, and I have tried to extract its concepts and attributes to see what has been found thus far. Various literature use different terminologies and tend show that the research studies do not have a standard terminology for these concepts. I have used a set of terminology and naming convention that I found is relevant for this thesis. Although a few of the success attributes were found to be addressed relatively lower than others, we cannot dismiss that those success attributes are still vital. The sets of success factors and attributes that I have presented in this thesis can be used as a data template for future projects and research, to further conceptualize them as methodologies and put them in practice.

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Appendix A: Online Scientific Search Engine Databases

Name	Address	Number of Studies Found	Date (latest search)	Filters
Science Direct	www.sciencedirect.com	109	16/05/2016	Sources: Computer Science; Content Type: Journals; Documents published within 2001 and 2016
Emerald Insight	www.emeraldinsight.com	1,863	16/05/2016	Search key: Anywhere; Documents published within 2001 and 2016
IEEE Explore	www.ieeexplore.ieee.org	18	16/05/2016	Advanced search using Metadata and Full text; Documents published within 2001 and 2016
SpringerLink	www.springerlink.com	167	16/05/2016	Discipline: Computer Science; Content type: Article; Documents published within 2001-2016
ACM Digital Library	www.acm.org	7	16/05/2016	Full-text filter and Abstract filter and documents published within 2001 and 2016
Engineering Village	www.engineeringvillage.com	60	16/05/2016	Documents published within 2001-2016
Scopus	www.scopus.com	360	16/05/2016	Documents published within 2001-2016
Web of Science	www.webofknowledge.com	54	16/05/2016	Documents published within 2001-2016
Google Scholar	scholar.google.com	83,400	16/05/2016	Documents published within 2001-2016

Table 7 Online Databases

Appendix B Extracted Data

Organizational Factor

Study	Customer Commitment	Clear and Flexible Planning	A well-defined Scope	Progress Tracking	Decision Time	Team Distribution	Planning and Control
SLR 1	Y	N	Y	Y	N	Y	Y
SLR 2	Y	Y	Y	N	N	N	Y
SLR 3	Y	Y	Y	Y	Y	Y	Y
SLR 4	Y	Y	Y	Y	Y	Y	Y
SLR 5	Y	Y	N	N	Y	N	Y
SLR 6	Y	Y	Y	N	N	N	Y
SLR 7	Y	Y	Y	Y	Y	Y	Y
SLR 8	Y	Y	Y	N	N	N	Y
SLR 9	Y	Y	Y	N	N	Y	Y
CS 1	Y	N	N	Y	Y	Y	Y
CS 2	Y	Y	N	Y	N	Y	Y
CS 3	Y	Y	Y	Y	Y	Y	Y
CS 4	Y	Y	Y	Y	Y	Y	Y
CS 5	Y	Y	Y	N	Y	N	Y
S 1	Y	Y	Y	Y	Y	Y	Y
S 2	N	Y	Y	N	N	N	Y
S 3	Y	Y	Y	Y	Y	Y	Y
S 4	Y	Y	Y	Y	Y	Y	Y
S 5	Y	Y	Y	N	Y	Y	Y
ES 1	Y	N	N	N	Y	N	N
ES 2	Y	Y	Y	Y	Y	N	Y
RP 1	Y	Y	Y	Y	Y	Y	Y
RP 2	Y	Y	Y	Y	Y	Y	Y
RP 3	Y	Y	N	Y	Y	N	N
Factors Addressed/ research studies	23	20	18	14	17	16	22

Table 8 Results from Organizational Factor

Technical Factor

Study	Clearly Defined Requirement	Supporting Tools	Documentation of System and Procedures	Properly Tested Software
SLR 1	Y	Y	Y	Y
SLR 2	Y	Y	N	Y
SLR 3	Y	Y	Y	Y
SLR 4	Y	Y	Y	Y
SLR 5	Y	Y	N	N
SLR 6	Y	N	Y	Y
SLR 7	Y	Y	N	Y
SLR 8	Y	N	Y	Y
SLR 9	Y	Y	Y	Y
CS 1	Y	Y	Y	Y
CS 2	Y	Y	Y	Y
CS 3	Y	Y	Y	Y
CS 4	Y	Y	Y	Y
CS 5	Y	Y	N	Y
S 1	Y	N	Y	Y
S 2	Y	N	Y	Y
S 3	Y	Y	Y	Y
S 4	Y	N	Y	Y
S 5	Y	Y	Y	Y
ES 1	Y	Y	Y	Y
ES 2	Y	Y	N	Y
RP 1	Y	Y	Y	Y
RP 2	Y	Y	Y	Y
RP 3	Y	Y	Y	Y
Factors Addressed/research studies	24	19	19	23

Table 9 Results from Technical Factor

People Factor

Study	Well-defined Competency	Motivated Individuals	Clear Communications and Negotiation between team member and Customer	Clear Composition of Team Members	Addressing training and Learning Needs
SLR 1	N	Y	N	Y	Y
SLR 2	N	N	N	N	N
SLR 3	Y	Y	Y	Y	Y
SLR 4	Y	N	Y	Y	Y
SLR 5	N	N	Y	N	Y
SLR 6	Y	N	Y	Y	Y
SLR 7	N	N	Y	Y	Y
SLR 8	Y	N	Y	N	N
SLR 9	N	N	Y	Y	Y
CS 1	Y	N	Y	Y	Y
CS 2	Y	Y	Y	Y	Y
CS 3	N	N	Y	Y	Y
CS 4	N	N	Y	Y	Y
CS 5	Y	N	N	Y	Y
S 1	Y	Y	Y	N	Y
S 2	N	N	N	Y	N
S 3	Y	Y	Y	Y	Y
S 4	Y	Y	Y	Y	Y
S 5	N	Y	Y	Y	N
ES 1	N	N	Y	Y	Y
ES 2	Y	N	Y	N	N
RP 1	Y	Y	Y	Y	Y
RP 2	Y	N	Y	N	Y
RP 3	N	N	Y	N	Y
Question Addressed/Research studies	13	8	20	17	19

Table 10 Results from People Factor

Process Factor

Study	Meeting with team on day to day basis	Clearly Defined Work Hours	Constant Customer Presence	Customer having full authority
SLR 1	N	N	Y	Y
SLR 2	Y	N	Y	Y
SLR 3	Y	Y	Y	Y
SLR 4	Y	Y	Y	Y
SLR 5	Y	N	Y	Y
SLR 6	N	Y	Y	Y
SLR 7	Y	Y	Y	Y
SLR 8	N	N	Y	Y
SLR 9	Y	Y	Y	Y
CS 1	Y	N	Y	Y
CS 2	Y	N	Y	Y
CS 3	Y	Y	Y	Y
CS 4	N	N	Y	Y
CS 5	Y	Y	Y	Y
S 1	N	N	Y	Y
S 2	Y	Y	N	N
S 3	Y	Y	Y	Y
S 4	Y	Y	Y	Y
S 5	Y	Y	Y	Y
ES 1	N	N	Y	Y
ES 2	Y	Y	Y	Y
RP 1	Y	Y	Y	Y
RP 2	Y	N	Y	Y
RP 3	Y	N	Y	Y
Question Addressed/Research studies	18	13	23	23

Table 11 Results from Process Factor

Project Factor

Study	Non-Life Critical	Set Delivery Milestone but dynamic Schedule	Cost Evaluation Up Front	Risk Analysis
SLR 1	N	Y	Y	N
SLR 2	N	N	Y	N
SLR 3	N	Y	Y	Y
SLR 4	N	N	Y	Y
SLR 5	N	Y	Y	Y
SLR 6	N	Y	Y	N
SLR 7	N	Y	N	N
SLR 8	N	Y	N	Y
SLR 9	N	N	Y	Y
CS 1	N	Y	N	Y
CS 2	N	Y	N	Y
CS 3	N	Y	N	N
CS 4	N	N	Y	Y
CS 5	N	N	N	Y
S 1	N	Y	Y	Y
S 2	N	N	N	N
S 3	N	Y	Y	Y
S 4	N	Y	Y	Y
S 5	N	Y	N	Y
ES 1	N	Y	Y	N
ES 2	N	Y	Y	Y
RP 1	N	Y	N	Y
RP 2	N	N	N	Y
RP 3	N	Y	Y	N
Question Addressed/Research studies	0	17	14	16

Table 12 Results from Project Factor

Appendix C Research studies

Accepted Research Studies

Article ID	Title	Author(s)	Topic Addressed	Type of Research	Journal/Conference	Year
SLR 1	Evaluation and Measurement of Software Process Improvement— A Systematic Literature Review	Michael Unterkalmsteiner, A.K.M. Moinul Islam, Chow Kian Cheng, Rahadian Bayu Permadi, and Robert Feldt	Identifying evaluation strategies to assess the impact of various software process improvement	Systematic Literature Review	Software Engineering, IEEE Transactions on (Volume: 38, Issue: 2)	2012
SLR 2	Software development project success and failure from supplier's perspective: A systematic literature review	Paula Savolainen, Jarmo J. Ahonen, Ita Richardson	Project success and failure from a supplier's perspective	Systematic Literature Review	International Journal of Project Management 30, 458-469	2012
SLR 3	A contingency fit model of critical success factors for software development projects A comparison of agile and traditional plan-based methodologies	Arthur Ahimbisibwe, Robert Y. Cavana and Urs Daellenbach	Identifying and categorizing critical success factors and develop a contingency fit model contrasting perspectives of traditional plan based and agile methodologies.	Systematic Literature Review	Journal of Enterprise Information Management, Vol. 28, Iss 1 pp. 7-33	2015
SLR 4	A model of critical success factors for software projects	Goparaju Purna Sudhakar	Highlighting the product, team, project management, and communication factors as categories of success factors for software projects. It develops a conceptual model of CSF.	Systematic Literature Review	Journal of Enterprise Information Management, Vol. 25, Iss 6, pp. 537-558	2012
SLR 5	Leadership performance is significant to project success or failure: a critical analysis	Phil Nixon, Megan Harrington, David Parker	Analyzes how performance of leadership in project management determines success of project outcome.	Extensive systematic literature review	International Journal of Productivity and Performance Management, Vol. 61, Iss 2, pp. 204-216	2011
SLR 6	Software Project Management Practices: Failure Versus Success	Capers Jones	An analysis showing the pattern of success versus failure across large software projects.	Systematic literature review	Journal of Defense Software Engineering	2005
SLR 7	A Systematic Literature Review on relationship between agile methods and Open Source Software Development methodology	Taghi Javdhani Gandomani, Hazura Zulzalil, Abul Azim Abd Ghani, Abu Bakar MD Sultan	An assessment of the relationship between agile methodology and open source methodology, and how they contribute to successful projects.	Systematic Literature Review	International review on computers and software (IRECOS), Vol. 7, Issue 4, pp. 1602-1607	2013
SLR 8	Which model is best for the Software Project? "A Comparative Analysis of Software Engineering Models"	Anand Kr. Shukla, Archana Saxena	Exploring the basic problems in different software processes, and the key to success in each of the processes.	Comparative study conducted through literature review	International Journal of Computer Applications (0975-8887), Vol. 76, No.11	2013
SLR 9	Factors leading to the success and failure of Agile projects implemented in traditionally waterfall environments	Tanner, von Wllingh	Taking the agile critical success factors and, and implementing them in traditional waterfall environment	Interpretive Qualitative study using literature	International Journal of Project Management 31, pp. 459-472	2014

Table 13 Research Studies conducted through Systematic Literature Review

Article ID	Title	Author(s)	Topic Addressed	Type of Research	Journal/Conference	Year
RP 1	Success Factors of Agile Software Development	Subhas C. Misra, Vinod Kumar, and Uma Kuma	Various success factors broken into agile development principles	Review paper	Journal of System and Software, Vol. 82, Iss. 11., pp. 1869-1890	2006
RP 2	"Lots Done, More To Do": The Current State of Agile Systems Development Research	P.Abramsson	A study focusing on the limitations of agile methodology and improvements needed.	Review paper	European Journal of Information Systems 18, pp. 281-284	2009
RP 3	Empirical Studies of agile software development: A systematic review	Dybå, Dingsoyr	Detailing the principles of agile manifesto and related processes through thorough study	Review study	Information and Software Technology	2001

Table 14 List of review papers

Article ID	Title	Author(s)	Topic Addressed	Type of Research	Journal/Conference	Year
CS 1	Coordination Breakdowns and Their Impact on Development Productivity and Software Failures	Marcelo Cataldo and James D. Herbsleb	Levels of socio-technical congruence associated with software failures	Comparative case study done using data collection	IEEE Transactions on Software Engineering, Vol. 39, No.3	2013
CS 2	Moving From Waterfall to Iterative Development – An Empirical Evaluation of Advantages, Disadvantages and Risks of RUP	Jorge A. Osorio, Michel R.V . Chaudron, Werner Heijstek	Explores the benefits of using iterative development process versus waterfall process.	Exploratory case study	37th Euromicro Conference on Software Engineering and Advanced Applications	2011
CS 3	Obstacles to decision making in agile software development teams	Meghan Drury, Kieran Conboy, Ken Power	Explores the decision making in four stages of iterative cycle and how it leads to team success, project success.	Focus group	The Journal of Systems and Software 85, pp. 1239-1254	2012
CS 4	Software process improvement success factors for small and medium companies: A qualitative study	Muhammad Sulayman, Cathy Urquhart, Emilia Mendes, Stefan Seidel	Identify software process improvement success factors for small and medium web companies.	Grounded theory research conducting interview on focus group	Information and Software Technology 54, pp. 479-500	2012
CS 5	Understanding and Improving Software Productivity	Scacchi	Analyzes the factors that lead to productivity in a software development project	Case study	Advances in Software Engineering and Knowledge Engineering, Vol. 4, pp. 37-70	2005

Table 15 Research Studies conducted through Case studies and Focus group

Article ID	Title	Author(s)	Topic Addressed	Type of Research	Journal/Conference	Year
S 1	Critical success factors for software projects: A comparative study	Mohd Hairul Nizam Nasir Shamsul Sahibuddin	A study done on CSF on different project sizes across various domains and countries.	Extensive literature survey	Scientific Research and Essays Vol. 6(10), pp. 2174-2186	2011
S 2	The Interplay between Requirements Relationships Knowledge and Requirements Change towards Software Project Success: An Assessment Using Partial Least Square (PLS)	Ruhaya Ab. Aziz, Bernard Wong	Investigating how requirement relationships impact requirement change as well as software project success.	Survey	Procedia Computer Science 46, pp. 732-741	2014
S 3	A survey study of critical success factors in agile software projects	Tsun Chow, Dac-Buu Cao	A survey study on the CSF of Agile development projects.	Survey	The Journal of Systems and Software 81, pp. 961-971	2008
S 4	A quantitative study on Crtical Success factors in Agile Software Development Projects; Case Study IT Company	Arezo Nasehi	A survey study on the CSF of Agile development projects.	Survey	Master's Thesis, University of Borås	2013
S5	Success Factors of Agile information Systems Development: A qualitative Study	Markus Hummel, Alexander Epp	Interview based study focusing on the success factors of Information Systems development by detailing the concepts of success factors.	Interview based survey	48th Hawaii International Conference on System Sciences	2015

Table 16 Research studies conducted through Survey

Article ID	Title	Author(s)	Topic Addressed	Type of Research	Journal/Conference	Year
ES 1	Examining the impacts of organizational culture and top management support of knowledge sharing on the success of software process improvement	Jung Chieh Lee, Yih-Chearng Shiue, Chung-Yang Chen	Explores the need of knowledge sharing from top management to make software process improvement successful.	Empirical study developing a conceptual model	Computers in Human Behavior 54, pp. 462-474	2016
ES 2	Factors associated with software development agility of successful projects	Jim Sheffield, Julien Lemétayer	Factors in project environment indicative of software agility	Empirical study of successful projects	International Journal of Project Management, pp. 459-472	2013

Table 17 Empirical Research Studies

Rejected Research Studies

Title	Author(s)	Topic Addressed	Type of Research	Reason for Rejection	Year
Beyond the Waterfall: Software development at Microsoft	Cusumano and Smith	The approach to software development practiced at Microsoft	Case Study	Outdated and doesn't address agile success factors	1995
Software Process development and enactment: Concepts and definitions	Feiler and Humphrey	Definition of a core set of software processes intended to facilitate communications and provide a framework for future research	Empirical Study	Doesn't address agile, no proper definition on success	1993
A comparison between Agile and Traditional Software development Methodologies	Awad	A comparison on the core principles of Agile and Traditional processes	Questionnaire	No definition of success was given.	2005
Limitations of Agile Software Processes	Dan Turke, Rumpe	Addressing the limitation of Agile Software Development Process	Review Study	Though core principles are helpful, this paper doesn't use examples on how certain factors can lead to success.	2002
A comparative study of Different software development life cycle models in different scenarios	Mishra, Dubey	A comparative study on various software processes.	Comparative study	Focusing on positives and negatives of each process, but doesn't address success factors or how these factors lead to success.	2013
Running on Hybrid: Control changes when introducing an agile methodology in a traditional "waterfall" system development environment	Mahadevan, Kettinger, Meservy	Addressing how to control changes when traditional development process environments adapt agile	Case Study	Though somewhat relevant to this research, it doesn't explore the factors that could lead to success, rather how to avoid failure	2015
Survey on software development processing models	Bindal and Mehta	A comparison on various software process life cycle and look at feasibility of adapting them in an organization	Survey	No success factors is mentioned.	2015

Table 18 Rejected Studies

Appendix D: Taxonomy of Attributes Dimensions

Attribute Dimension	Organizational	Technical	People	Process	Project
Scope	A well-defined scope; Clearly defined requirements; Planning and control; Clearly defined work hours; Clear and flexible planning				Project with set delivery milestone but dynamic schedule; Project with cost evaluation up front; Project with risk analysis;
Tools	Progress tracking	Supporting Tools; Properly tested software; Documentation of systems and procedures			
Customer	Customer commitment;		Clear communication and negotiation between customer and team	Constant customer presence; Customer having full authority; Meeting with team on day to day basis	
Team	Team distribution		Well-defined competency; Clear composition of team members;		

Table 19 Taxonomy of attribute dimensions