



Enhancing the Potential of Software Metrics in Saudi Arabia: CMMI & ISO 9001 and Agile Methodology

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Abstract

This study evaluates Saudi Arabian companies based on their adoption of mainstream software development methodologies like Agile, ISO9001, and CMMI. The responses from 25 respondents representing 22 small to large Saudi enterprises, this research proposes a model that shows how brand value is affected by the adoption of particular Software Development methodologies. Having many critical observations, first, small to medium companies that are focused on growth and software development, prefers Agile development methods over more resource-intensive methodologies like ISO 9001 and CMMI. Second, mid to large Saudi companies seeking clients' trust and assurance, focused on traditional documentation intensive standards like ISO 9001 along with Agile. Third, large and prime Saudi contracting companies focused on stability and predictable success for their entire projects and as a result favored CMMI, along with ISO 9001 and Agile. The flexible methods used as tries by developers to avoid writing documents did not benefit the end system. Moreover, ISO 9001 emphasizes audit and documentation processes as understood by developers. Also, Software measurement is an important part of the software engineering situation. This paper introduced a metric, for the assessment of the brand value of a Saudi Company based on their level of adoption of software engineering methodologies. From a practical point of view, this paper shows which software development methodology is more suitable and practical for a particular Saudi Arabian company.

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1 Introduction

With the Agile development of agile methods, some developers find that ISO 9001 and other quality assurance standards have become redundant or no longer needed. The idea seems to be that ISO 9001 compliant processes are not compatible with agile development processes. Our goal is to show that it is better to combine these two methods in practice than to separate them, and if you combine the two, it will be useful for the project. Many potential customers require a development company of Saudi Arabia to obtain a certificate agreement before obtaining ISO certification (Moran, 2014). This applies to government agencies and private companies. The main reason is the trust that ISO 9001 certification has created. It is much easier to check if a company is ISO 9001 certified than to check if a company has a good development process, and if so, follow it. Many companies have also passed the ISO 9001 certification and want to maintain certifications if they can develop rapidly (Moyon et al., 2018). This paper tackles the process of software that has been used by their companies in Saudi Arabia. Moreover, it would highlight the steps involved in applying the software metrics within Saudi organizations.

The idea of harmonizing agile development with ISO 9001 could be almost as old as agile development itself. While agile developers don't see it as a problem, many QA managers and employees do. One problem in the current body of literature is that some authors do not understand ISO 9001 or do not know that the new ISO 9001: a process-oriented assessment has replaced the 2000 standard. A typical example is an article by Hoda et al. (2017); their main arguments often revolve around claims such as "the application of objective design rules leads to sustainable systems." Meyer and Nordio (2016) offered another simple but feasible solution to this scenario. By treating each period or step as a separate entity, ISO 9001 compliance is eliminated from the process, but this solution creates more timelines than just document development. In a 2007 article, Ghaisas et al. (2016) discussed modulation and agile development in ISO 9001. Their main claim is that XP and Scrum together meet all ISO 9001 requirements. Their discussion was a bit difficult, but when they said: "ISO 9001 is not of equal quality. Boehm and Turner are in discussion. The need to balance agility and discipline, Green and Chao (2017) pointed the finger at the same problem. Ghobadi and Mathiassen (2016) discussed the entire MWC range, ISO 9001, and their relationship to XP and Scrum. Most of the requirements of ISO 9001 are related to the development method used, and that they are part of the current processes. Dwivedi et al. (2018) provide agile development and ISO 9001. The method has so much in common with the method we will use later in this article - check the ISO 9001 requirements step by step and see XP and Scrum to see which methods that meet the standards should offer. However, we do not agree with some of his claims and the general conclusion that XP does not need to change its focus to two things to highlight the slight development problems associated with ISO 9001: XP is comparable to ISO 9001, and the other is XP and TickIT.

1.1 Agile Development

Agile software development is an organizational development process that emphasizes the best direct and multifaceted communication, an increase in frequent presentations of software work, short repetitions, and active customer participation everywhere. Life cycle development and response to change rather than avoiding change. This can be seen as the opposite of a cascade process that emphasizes thorough and in-depth planning, design consistency, and continuous planning (Abrahamsson et al., 2017). Over the last decade, agile methods seem to address common issues such as budget congestion, evasion, and the creation of high costs in terms of reports, formalities, transformations, and broad formats, which arouses a lot of interest in popularity management (Ghaisas et al. 2016). Agile strategy briefly describes the basic concepts of fast software development. Agile software development can be thought of as a philosophy, and based on these ideas, several defined methods are used, all of which have common values and principles.

Compared to the rigid waterfall model, the agile process involves and attracts the original customers with each repetition and termination. In each iteration, customers and the development team work together on scripting, knowledge sharing, and validation testing requirements can be seen in Figure 1.

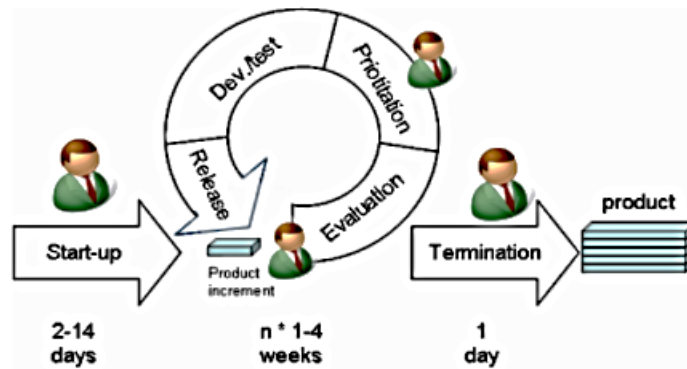


Figure 1: Customer involvement in agile development.

In Figure 1; customer participation in agile development has been used for many decades in many industries as a cornerstone of the Japanese industry. Innovation is probably the most famous example. However, some important changes are needed to make it suitable for software development. The basic principle of implementing deficit development is the principle of waste: All work and work products that do not directly contribute to software development should be considered waste and avoided or reduced. Since 1999, when Kent Beck published his first book on extreme programming, people's interest and use in the industry have grown rapidly.

In most cases, there is a huge interest in the industry from the developer. This can be explained by the simple and human-made values of agile methods, which may be attractive to practitioners but endanger society. The basics are easy to understand and seem to solve developers' basic problems (Alahyari et al., 2017). However, despite this interest and desire to fundamentally change the development process, some critical voices have emerged. Many empirical reports

suggest that this approach is not straightforward - in most cases, it is a balance between agility and discipline. Agile methods' criticism is that the use of documents must be consciously avoided, as this can be considered waste; documents are not software, and software development should develop software rather than documents. This is a strict concept that may explain the widespread belief that agile software design does not meet known quality assurance standards (such as ISO 9001). As we will explain later, this is not necessarily the case (Al-Zewairi et al., 2017).

1.2 ISO 9001 Requirements

To obtain ISO certification, a company or organization must provide documentation that describes its internal processes, procedures, and standards. These documents (or quality management systems) confirm that the company can continuously provide quality products and services.

ISO 9001 requirements provide a set of standard elements to guide you by implementing a quality management system (QMS). These requirements apply to all companies in all industries, based on production and service requirements, so these requirements tell you what aspects of QMS are needed, but they can't tell you how to proceed. These are important elements.

The ISO 9001 requirements are broadly divided into eight clauses (known as ISO 9001 clauses), five of which include mandatory requirements for the quality management system: general requirements for the quality management system, management responsibility (Clause 5), and resource management (Clause 5) (Clause 6). Product introduction (Clause 7) and measurement, analysis, and improvement (Clause 8). All aspects of these five provisions are mandatory, except the section on "Production of products," which allows companies to exclude inapplicable goods but cover the standard's scope to understand better the references, terms, and definitions of the standard.

The most serious difficulty in implementing the standard requirements is to ensure that the final policies, procedures, processes, and files collected meet the company's needs and customers as soon as the system is improved. Improving the system is one of the main reasons for implementing QMS, as it is beneficial to the company in the long run.

At the highest level, the requirements of ISO 9001 are summarized as follows:

- The company must have a quality management process - Clause 4.
- Senior management is responsible for product quality - Clause 5. Company management should, therefore, provide the resources needed for quality assurance and training - Clause 6.
- The company must have one or more documented product manufacturing processes - Clause 7.
- The process must produce documents that can be (1) reviewed and validated and (2) used to demonstrate compliance.
- Report and analyze any reports of non-conformity of the product or process and take corrective action - Clause 8.

In addition to ISO 9001, the ISO 90003 document is also very important. This is not a standard but a guide to using ISO 9001 in software development and maintenance. ISO 9001 emphasizes situations where we have contracts or enter into contracts. The contract is awarded according to a defined process. One of the things that come with this process is reassuring customers that the quality meets the requirements, and that is why it is very important to follow this process. ISO 9001 considers document auditing to be its main management and control process (Drury-Grogan et al., 2017).

In this paper, we presented an assessment metric to ascertain the level of adoption to Software development methodologies by Saudi Arabian companies (Eq 1 of Section III). Next, we used this equation to assess 22 Saudi Arabian companies, for determining their brand value (Figure 2 within Section III). Our result shows that 82.5% of the Prime Saudi Arabian contractors adopted CMMI, ISO9001 and Agile practices within their projects. We have summarized the prime features and differences among CMMI, ISO 9001 and Agile within Table 1 of Section III. Finally, using the summarized information in Table 1, we described a model showing which particular software development methodology is more suitable and practical for a particular type of Saudi company. This model is presented as a decision tree in Figure 3.

2 Research Methodology

2.1 Research Design

The concept of research and methodology is always linked to the testing of relevant new and different technologies and evaluating the whole process and procedure, but to different but innovative results, which generally helps to create new methods and procedures.

Some steps should be considered by trial and error. It also gives researchers a special understanding of the same concepts. When trying new things with different technologies, they can be confident in the process and help get the details: opinions and information. The possible consequences are the same (Dragicevic, Celar, and Turic, 2017).

The whole process has been repeatedly studied and researched, which made the concept clearer and clearly showed its advantages and disadvantages. This chapter discusses various research methods, including questionnaires, selection interviews, and data analysis. This study is based on the onion research framework. The research method's layer contains a philosophy that can be said simply about a positive, explanatory, and critical philosophy. Choosing the right research methods to achieve lasting and desirable results that companies can confidently achieve is a major achievement. The research method is essentially a way to achieve the desired results. There are two types of research methods that are recommended and far-reaching. Evidence methods deal with specific but basic research concepts, while absurd methods deal with theories and analyzes (Ghaisas et al., 2016).

The data collected in this study are mostly qualitative, and therefore we consider an inductive research method (Drury-Grogan et al., 2019). There are different processes for conducting research, such as practice, experience, and basic theory. With the appropriate assistance of test

methods, the person concerned should consider test methods to complete the analysis. Researchers can easily identify key issues and provide detailed reports on the same topic.

2.2 Methods of Data Collection

In-depth interviews were conducted to collect real-time data on specific groups, which is crucial for researchers to obtain a realistic and reliable understanding. Since these data are specific and targeted Saudi Arabian companies, senior research leaders were concerned about the format, language, and cultural adjustments for the area of study. Approximately twenty-two companies were selected and 25 questionnaires were handed out electronically using MS Forms. Once the data were received within MS Forms, MS Excel was used for conducting data analysis.

2.3 Design Interview Questions

The interview as a whole is divided into three main parts, or the first part of the question is demographically based, which helps the researcher to assess the interviewee's and interviewee's background and use them to assess background, race, and race interviewees to share relevant research and practice some ideas (Strode, 2016). Finally, IT managers and executives are asked to share their thoughts, opinions, and suggestions throughout the software development process.

3 Results and Discussion

3.1 Transcribe And Verify Interview Data

Interviews are conducted to ensure a good understanding of the process. Data stored in a specific format will no longer be collected. The data collected during the various inspections and subsequent operations were handed over to the same personnel, and several meetings were held. Finally, the interviewee was interviewed, and the reliability of the document was checked. We have taken all necessary precautions to follow the procedures, and once the data is confirmed, it was sent to the respondents for final confirmation. The data was saved with a password-protected document that was only visible to the researcher. The current policy is positive, as administrations are well equipped, and technicians are responsible for the work. The company faces external challenges and challenges, but its training and internal management have received a positive response.

3.2 Thematic Analysis

The coding process has three main stages: organization, business process, and technical process. The first large device, called the Atlas, was used for research. The software is used to define them, and once the whole coding process is complete, it also helps with system coding; the technician should check the overall functionality of the data. In this situation, it is up to the researchers to identify and test all the data and resources collected, which must be efficient enough for further processing. Depending on data management's capabilities and reliability, the coding system is also divided into several programs, which must accept all tasks and functions and cover all gaps. These skills are needed and must always be productive, efficient, and innovative.

This study focuses on two main topics (namely, Topic 1: Defining the software process used by a Saudi company and Topic 2: Application challenges related to software processes used in Saudi Arabia). On topic 1, people have found that CMMI is widely used. It was considered necessary to reach the level of development recommended by the Department of Software Engineering (CMMI), level 2. Due to the software, the related software ads have been processed in a standard way. There are several benefits to deploying this software. Quantitative management decisions are made in the software age, which is increasingly enjoyed by Saudi companies' employees.

In other respects, the main challenges of the project are organizational and technical problems and conflict-related challenges. These challenges improve local governance practices (Rehman et al., 2018). The right role in organizational activities and employees' well-being need to be improved and balanced. End-users are happy and satisfied because the implementation is efficient and effective. The main problem is the lack of communication with employees. Users have a positive side because their plans for understanding and implementing are very effective. Software selection is essential for successfully implementing the overall goal (Curcio et al., 2018).

ISO certification can help companies and organizations gain a competitive advantage over their competitors and win many customers. ISO standards can also help improve an organization's internal performance and workflow by ensuring that all criteria are met in all business areas. If these conditions are not met, the final product will never be a suitable standard.

An appropriate and thorough study should be performed to select the perfect diagnostic method, as vague and irrelevant data are likely to emerge. In other words, if the sample size is smaller than the risk of error, it is larger. If the sample size is large, the probability of chance arises, and the probability of chance is less than the probability of marginal error (Schmidt, 2016). In all cases, researchers can find a suitable solution, i.e., if a large amount of data is used, the margin's potential is lower than if little data is collected and the benefits benefit the respondent. The survey failed because the respondents could not explain the problem, and the chances of errors were high. In the first year, the recruitment and selection processes have been completed by contacting small and selected companies and managers, as there is a great need for their accepted role in selecting the sample. An advertisement was also created where IT professionals monitored and participated in this process. Participate in the same way. Smart methods can also be applied using the same smart mobile app, giving respondents 40-50 minutes to share their thoughts and get aggregate results (Ghobadi and Mathiassen, 2016).

IT managers or leaders should familiarize themselves with quality management, deal with complexity, additional issues, and so on. On the other hand, other companies have been established in various fields, and CMMI is global. Validated models can also meet the needs of these industries (Ghobadi and Mathiassen, 2016).

In the economy, IT departments do not always have many other departments to manage and control. CMMI enables these parties to strengthen their work culture and improve communication with stakeholders and, thus, the organization's future performance (Curcio et al., 2018).

Research shows that CMMI is a fast and flexible method for reviewing and evaluating new and emerging companies' business processes. In-depth research is the process of evaluating and measuring scientific testing processes, procedures, and studies with a deep and well-thought-out understanding of psychology. Incorporating software metrics into an organization greatly helps organizations and companies analyze and evaluate the company's quality and functionality (Anwer et al., 2017).

Wright reviewed ISO 9001 and XP formats: "At the appropriate level, design and development should be systematically reviewed according to planned procedures." The author argues that programming pairs are a constant change of code. However, this proposal does not meet most of the existing definitions of code revision - see, for example. When programming pairs, there is no systematic overview of system design, as the emphasis is on coding others. Also, paired programming does not include documentation, which makes subsequent review difficult. In a comparison table between TickIT and XP Wright, he noted that "customer cases and validation tests perfectly define software requirements." (Drury-Grogan et al. 2017). There are two problems with this statement. First, the recognition test clearly defines the requirements as incorrect. Although new developments in automatic entrance examinations may change this situation, entrance examinations are written as needed and not vice versa. Second, the customer's case is too wrong to meet demand. Requirements are defined by three stories and customer approval (usually not in writing). Dwivedi et al. (2018), using a method similar to Wright's. Their processes are already in line with ISO 9001. Their challenge is to find a process that can process the process flexibly by maintaining ISO 900. They call it automation, and the method seems to be successful - they have adopted and developed agility in development. E-commerce management to maintain ISO 9001 compliance Dragicevic, Celar, and Turic (2017) focus on the seventh part of achieving an ISO 9001 product. This is the part of skill development that has the greatest impact on ISO 9001. This article gives a good overview of the relationship between this part of this standard and ISO 9001, but the rest of the standard is the same. The author has designated the ISO 9001 7.3.2-7.3.7 project as the most important Agile challenge process that meets ISO requirements. Moyon et al. (2018) studied ISO 9001 and XP to use both project modification project ideas. He pointed out that "the desire to pay attention to sustainable development ideology is the main driver of adaptation." Moran (2014) is important because the author tested XP and part of ISO 9001. As stated in the article, the main conclusion is that the XP project of this test suffered from problems such as poor sustainability and poor sustainability.

However, their purpose is not to examine the additions needed for agile development to maintain ISO 9001 compliance, but to see how agile development projects meet ISO 9001 in a case study. In Lappi and Aaltonen (2017), Victoria reviewed the entire TickIT standard and analyzed its use in two examples. In both complex projects, he found that 33% of TickIT could not be used in XP projects, 24% could be used in part, 20% could be fully used, and 23% was not important, as both projects were learning projects.

Table 1: Prime differences between the assessed methodologies in Saudi Arabia

Definition	Agile	CMMI	ISO 9001
	Methodology	Model	Standard
Certification Authority / Governing Body	No centralised body. Certified Agile Practitioners can introduce the suitable set of methodologies within the organisation	CMMi Institute	Different bodies under the main body of ISO (Third Party Certification)
Application	Software Development	Process Improvement, Software Engineering, System Engineering, Software Acquisition	Broad Focus, ranges from Software Development organisations to manufacturing industry
Focus	New Process and Products	Measure Quality of Existing Processes	Focus on having a process
Main Goal	Shippable Product	Organizational Improvements	Documented Processes
Management Processes (risk, quality etc.)	Not Included, Less Rigorous	Standardized, More Rigorous	Less Rigorous
Resource Requirement	Very Less	Large budget for Appraisals and Human resources for continuous assessment of existing processes	Medium budget for Auditing and Human resources for process documentations
Delivery	Delivers Rapid Growth and Productivity within the Organisation	Promotes Stability and Predictable Outcome for the for the Organisation	Delivers Assurance for the clients of the Organisation
Suitable Organisations	Wide range of enterprises starting from Startups, offshoots etc.	Large Enterprises	Medium to Large Enterprises

Since measuring the adoption of software development methodology is crucial for this research, we designed a metric. We then, used the metric against all the 22 companies, to understand their level of adoption for each of the software development methodologies.

Our metric assessed the brand value of Saudi Arabian enterprises using the formula below:

$$M = 5X \sum_{i=0}^I C_i + 3X \sum_{j=0}^J S_j + \sum_{k=0}^K A_k \quad (1),$$

Where

$$C_i = \begin{cases} 1 & | \text{Phase } i \text{ of CMMi is Adopted} \\ 0 & | \text{Phase } i \text{ of CMMi is not Adopted} \end{cases}$$

$$S_j = \begin{cases} 1 & | \text{Phase } j \text{ of ISO9001 is Adopted} \\ 0 & | \text{Phase } j \text{ of ISO9001 is not Adopted} \end{cases}$$

$$A_k = \begin{cases} 1 & | \text{Phase } k \text{ of Agile is Adopted} \\ 0 & | \text{Phase } k \text{ of Agile is not Adopted.} \end{cases}$$

Our questionnaires were composed of the questions in regards to the current adoption of phases for each of the assessed methodologies (i.e. Agile, CMMi, ISO9001) by individual Saudi Arabian companies. For example, if a company adheres to all the five phases (i.e. *plan, develop, test/QA, Deliver, Assess*) of Agile methodology then we would record a set of $\{A_1, A_2, A_3, A_4, A_5\} = \{1, 1, 1, 1, 1\}$. If another company does not have any *Assess* phase within their Agile approach, then we would have $\{A_1, A_2, A_3, A_4, A_5\} = \{1, 1, 1, 1, 0\}$ for that company.

In the end, we would have three different arrays for each company (C, S & A representing CMMi, ISO 9001, and Agile) depicting whether that company adopts a particular phase within their practice or not. Metric, M then shows us the perceived brand value for that company.

Figure 2 shows the final result from the questionnaire after we have computed metric, M for all the assess companies. All the prime contractors of Saudi Arabia had adopted one or more phases from all three methodologies (i.e. Agile, ISO 9001, CMMi).

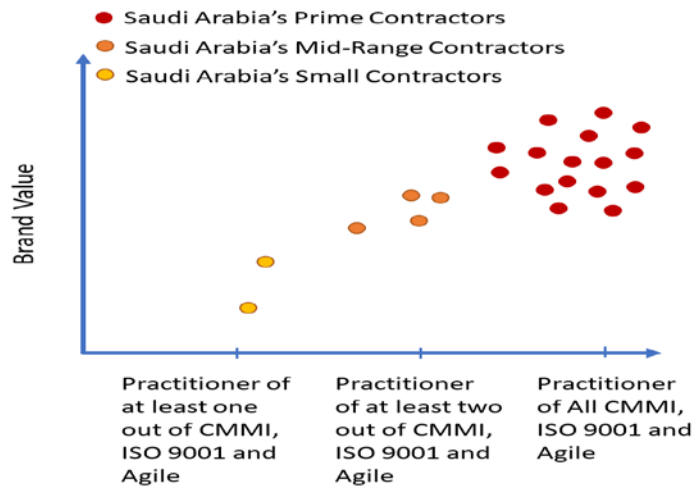


Figure 2: Perceived increase in brand value with the adoption of Agile, CMMi, and ISO 9001.

Responses from 25 respondents suggest that adherence to all AGILE, CMMi and ISO 9001 methodologies are required for Saudi Prime contractors and enterprises that focus on software development, aspire to be the market leader within 5 years, possess existing processes and have access to adequate budget and resources. Enterprises whose main focus is not software development (i.e. manufacturing of embedded devices, or other engineering disciplines) can take the pathway for ISO 9001 certifications through third partly ISO bodies. Aspiring to be a market leader requires stability, predictability and client confidence, which can be achieved through obtaining CMMi and ISO 9001 certifications. Lastly, without access to sufficient budget and human resources, enterprises could not possibly adopt the pathways to ISO 9001 and CMMi certifications. Figure 3 shows a decision Model for the adoption of AGILE, ISO 9001, and ISO 9001 in Saudi Arabia.

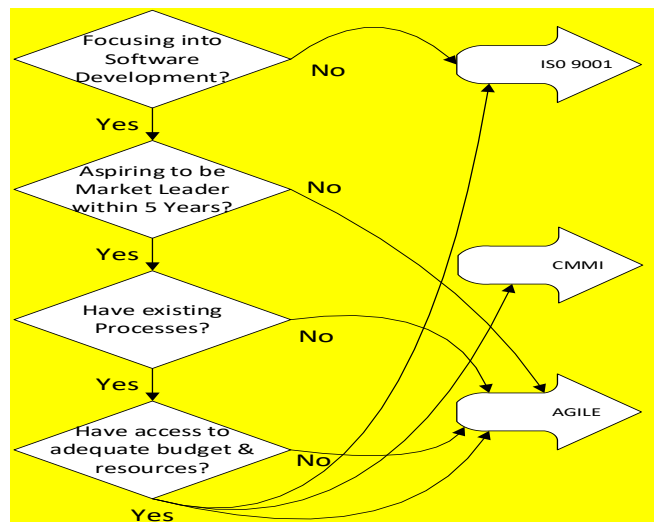


Figure 3: Decision Model for the adoption of suitable methodologies in Saudi Arabia

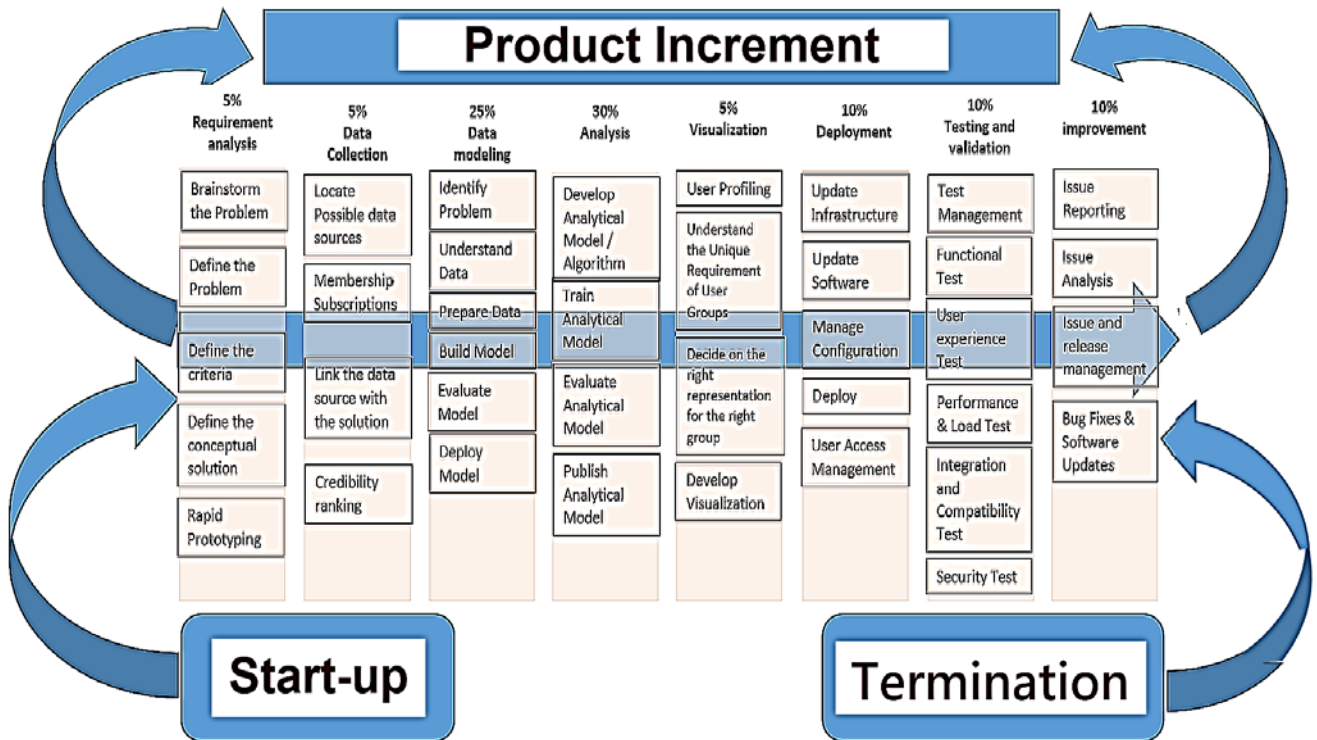


Figure 4: A typical Software Development Methodology covering a combination of Agile, ISO 9001 and CMMI as practiced by a Saudi Arabian Company

Developments also show how process changes affect progress.

This study includes three case studies of software indicators that add value to the organization. Several prime Saudi contractors are already in the process of adopting CMMI, ISO9001 as Agile methodology within their practice. As depicted in Figure 4, one Saudi company uses a custom software development methodology that has both an iterative approach of Agile, as well as more rigorous documentation practices that might assist ISO9001 as CMMI. From this example (Figure 4), we can see that “*Define the problem*”, “*Define the Criteria*”, “*Define the conceptual solution*” within the Requirement Analysis process would facilitate rigorous documentation processes as mandated by methodologies like ISO 9001. This study result will contribute to the development of software programs and gain access to the operation and functionality of the software system from a scientific and more systematic perspective. The discussion of this study showed that Software measurement is an important part of the software engineering situation. More and more customers are quoting software reports and quality metrics as part of their contractual requirements. Measurement standards include industry standards such as ISO 9000 and industry models such as the Integration of the Functional Maturity Model (CMMI) of the Institute of Software Engineering (SEI). Companies use metrics to understand better, monitor, manage, and forecast software projects, processes, and products. The term software measurement means different things to different people. When we buy books with software dimensions or read articles on a software scale, topics can range from project costing and modeling and workload forecasting to bug fixes and causal analyzes and specific testing scope metrics. Evaluating and measuring all stages, approaches, and activities of software development and end products is an old and powerful discipline and research area.

4 Conclusion

Based on the section's discussion the main difference between ISO 9001 and Agile methods is that ISO 9001 emphasizes audit and documentation processes. Flexible methods try to avoid writing documents that do not benefit the end system. On the other hand, if customers need special documents using agile methods, this does not prevent them from growing. There are many ways to handle the many documents required by ISO 9001. We can add tasks such as audit meetings and draft documents. According to the project contract, there are always the most important flexible ideas in the process, such as short iterations, growing customer demands, resetting priorities as needed, and constantly adjustable scope, time, and costs. A lively community talks about "doing things as simple as possible." The term "simpler" does not mean that more artifacts or processing operations are excluded. However, a limited number of new entities can be added to the flexible provisions, and they still need to be marked as flexible. However, the changes required to comply with ISO 9001 remain within these limits. The distinction between fast and fast development process, according to ISO 9001, is not impossible from the above discussion. However, some changes are required to be made.

Software metrics are very easy to manage because simple numbers representing Key Performance Indicators (KPI) denote complex processes. These KPIs represented by numbers are easy to compare with other numbers. Thus, it is easy to declare the software successful in achieving its goal. If the company doesn't reach that number, the software development team knows they need to work harder to reach that goal. Moreover, these simple goals don't provide much information about software development. No data point is as important as its evolution. Analyzing why the direction line is moving in a certain direction or how fast further explains the process.

This paper proposed a simple measurement for the assessment of adherence to software development metrics and methodologies for Saudi Arabian companies. With the help of this measurement, we assessed 22 Saudi Arabian companies to find out their level of adherence to mainstream software development methodologies. Our result shows that about 82.5% of the Prime Saudi Arabian contractors adopted CMMI, ISO9001 and Agile practices within their projects. Mid-size Saudi enterprises 89% prefer Agile along with ISO9001. On the other hand, 93% of small enterprises including entrepreneurs and startups focused only on Agile practices. Finally, this paper proposes a model for Saudi Arabian companies showing which particular software development methodology is more suitable and practical for their modus operandi.

5 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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