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A Systematic Literature Review on Software Metrics

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Abstract

This study aims to explore the use of software metrics by companies within Saudi Arabia. For this purpose, we have used the System Literature Review (SLR) method in the group of research libraries. We analyzed all the major studies on the content of evidence for software maintenance in the literature. A software metric is a measure for the characteristics of software that are countable or measurable. The software metrics would help the organization or private entity to analyze the quality of the software. The article follows different System Review (SR) criteria such as Implementing the sustainability of the software program (sustainability of any element/sub-element and defined in many quality models) to predict and provide the following elements. This study presents the select metric tools in the literature, their metrics, and the functionalities utilized by the tools. Furthermore, this study's main contribution is to make a list of metrics used by the tools and the classification respective as per the use in the software industry. The findings of this study can be used theoretically and practically. From a theoretical point of view, this study would bridge the gap in the lack of literature within Saudi Arabia regarding metrics used by Saudi companies.

Disciplinary: Information System and Computer Science & Engineering (Software Engineering).

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1 Introduction

A software metric is a measure for the characteristics of software that are countable or measurable (Alexandros et al., 2017). Software metrics are the measurement of the software product and the process by which it is developed. Ordinarily, these measurements of the software and products are studied and developed for use in modeling the software development process.

Then these models and metrics are used to estimate, forecast, and calculate the efficiency and quality of the product. In the management and control of the development process, knowledge extracted from metrics and the model which then be used which will, one hopes, contribute to improved results (Mills, 1988). Software metrics are primarily the interest of practitioners and researchers. Moreover, the software metrics are the primary aid to the software measurement process, and the advanced software continues to be further defined by the community of research.

The measurement of software involves the tasks that are particularly carried out during all the software phases of software development. According to the study, Acosta et al. (2015) stated that many final or intermediate software products are further measured and developed with the help of software products metrics during the process of the software metrics. Also, one of the software metrics products is project management like time, scope, cost, and overall quality, which is the part of the system of final software and is generally measured for assessing the quality. The measurement is particularly achieved by the characteristics mapping of the measured entity to the numerical value like considering (Abrahamsson et al., 2017).

As per Al Hamed and Alenezi (2016), the inclusion of the software metrics will assist the organization or other private firms in analyzing the software's quality. They also help in the development and assessment process of the software and the software functionality by using the software metrics' systematic approach. This article focuses on the different types of software metrics, which can increase the business value in enterprises. Alahyari et al. (2017) refer that the system of quality management is used in areas like Saudi Arabia. Many companies are adopting ISO 9001 for manifesting the capacity to consistently increase the affordability of products and services, which will fulfil the regulatory and customers' needs.

The software metrics would help the organization or private entity analyze the software's quality (Alexandros et al., 2017). It would also assist the software development process and assess the functionality of the software in a systematic approach (Alghamdi et al., 2018). Establishing a software methodology is not a small endeavour; rather, the complexity arises with the procedure (Alliance, 2015). However, this study will consider three types of software metrics that increase the business's value in enterprises (i.e., ISO 9001, CMMI, and Agile methods) (AlMutairi et al., 2015). This would lead to a challenge in comparing software through doing lines of code without a standard definition.

Thus, it is necessary to create a method of measurement and consistent units of measurements to be implemented during the life of the project (Alqahtani, 2017). That is why more flexible and result-oriented software needs to be developed to fulfil the organizations' needs. Result-oriented software concentrates on software's size and is normally manifested as Kilo Lines of Code (KLOC) (ALresheedi et al., 2018). It is relatively easy to handle software metrics to gather once decisions are made regarding what makes a code line. This study considers ISO 9001, CMMI, and agile methods as a road map to measure and study software processes in companies. In detail,

the science of measurement is a process of conducting scrutiny and developing a deep understanding of the well-established philosophies (Al-Saleem and Ullah, 2015).

This research in progress has examined the use of the agile method of Scrum in Saudi enterprises, a framework for addressing complicated adaptive problems to deliver products with the highest possible value. The method of scrum is simple, and the entire process is result-oriented. That is why various mid-sized organizations tend to adopt this software development method (Alshehri et al., 2016). It divides the development process into small intervals, making this process highly functional and result-oriented (AlShathry, 2016). However, within Saudi Arabia, there is low reliance from the decision-makers in the organizations on using software metrics, and the main reason for this is the relatively new background of this subject (Ariza et al., 2018). Based on this, the authors believe that this research in progress will provide a valuable result that contributes to the literature and understand the agile method's current use by different Saudi enterprises.

The article is more inclined to use software metrics used in Saudi Arabia and the government's standards to enhance the customer's experience. The software developed in recent times is more interested in customer preference; the interface and user experience are improved with every update. The article provides research questions and objectives for detailed analysis. The challenges of applying efficient software within companies are mainly related to preparing well-trained staff who can ensure well-educated software metrics implementation. Moreover, issues of the budget must be considered when purchasing and updating the use of software metrics and addressing the challenge of interoperability with other technological systems within the companies (Aversano et al., 2017).

The main objective of the study was to describe the most common indicators of software metrics in recent years, tools used to describe the software metrics, and mapping and calculation tools. To achieve these three objectives, we used the System Literature Review (SLR) method in research libraries.

This study aims to explore the use of software metrics by companies within Saudi Arabia. This paper presents a systematic review conducted to collect evidence on software maintainability prediction and metrics. This article presents the results of a system audit to gather evidence on forecasting and software sustainability. The purpose of this article is to identify software characteristics and evaluate their usefulness in predicting software failures. We examined the impact of context on the choice and performance of indicators.

This study will help the managers help maintain the software prediction model's maintainability that will help the enterprises predict the software system maintainability. Moreover, this study will also provide the means so that the company will also manage and maintain the resources to adopt the defensive design. Furthermore, this study will also help the managers reduce their overall maintenance efforts that will eventually reduce overall mean time and cost in the company's software projects. This study will improve the overall understanding of the software metrics process in making an important contribution to the company's performance.

The structure of this article is as follows. Following the presentation, an overview of the systematic review process will be provided. The third part describes a systematic audit method for software measurement. Then provide a breakdown of the results. Finally, the collection and future work are discussed.

2 Systematic Literature Review

To answer a simple question, a systematic literature review (SLR) describes, selects, and objectively reviews the study (Dewey & Drahota, 2016). In this systematic analysis, a clearly specified protocol or strategy should be followed, where requirements are clearly defined prior to the review. This is an extensive, transparent study that can be replicated and reproduced by other scientists through numerous databases and gray literature. The plan requires a well-designed search strategy with a particular emphasis or answers to a given problem. The analysis describes the type of information that has been requested, criticized, and published in known timescales. All search words, search policies, and restrictions need to be included in the analysis (including database names, platforms, search dates) (McNally, 2020).

The systemic review of literature is a method/process/protocol for aggregating, reviewing, and analyzing a body of literature using pre-specified and structured techniques. In other words, to avoid partiality, the reasoning, hypothesis, & data collection methods are drawn up before analysis and are used as a reference for the procedure. The aim is to describe, critique, & sum up the current proof of a clearly-defined issue, just as it is for conventional literature reviews (Štrukelj, 2018).

The systematic literature review is the other form of study that examines and identifies the studies relevant to the study's particular research question. While, among the significant characteristics this article highlighted the studies (Balijepally and Nerur (2015), Bayona-Oré et al. (2019), Hoda et al. (2017), this is the process of SLR which it defines before the start of the study. This overall protocol explains the study questions to be further analyzed and approached and which techniques will be used in the study. This develops the creation of a good structure and documented study strategy.

This strategy is required to be effective enough for getting a higher amount of primary research relevant to the study's aims and topic. This implements the exclusion and inclusion criteria for the evaluation of the primary researcher found. The Systems Literature Review (SLR) is a complementary form of research that aims to analyze and analyze research related to a research question. Among its features, we can highlight: it has an SLR process defined at the beginning of the search. The agreement defines the research problems to be solved and the methods used in the research; it recommends creating a well-documented search strategy. This policy must be good enough to be the most basic search in the literature on the subject. Differentiation and exclusion criteria are used to evaluate the main studies found. Moreover, the systematics review that is used in the study is composed of the primary three stages such as the researcher made SLR whose directives were given between Mahalakshmi and Sundararajan (2015), Lindsjørn et al. 2016), Kaur (2015), and Hoda et al.((2017). An SLR is a research method for the systematic review of literature

in clear steps (Aversano et al., 2017). The SLR mainly consists of three stages: planning, implementation, and reporting as shown in Figure 1.

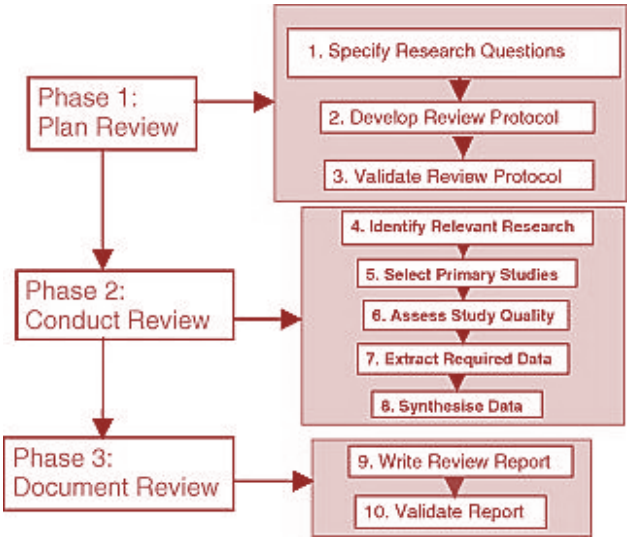

Figure 1: Process of Systematic Literature Review (Source: Brereton et al., 2007).

Various researchers have studied software metrics and their tools, shown in Table 1.

Table 1: Review of software metrics works.

Authors	Title	Aim	Methods	Conclusion
Abrahamsson et al. (2017).	Agile Software Development Methods: Review and Analysis	Filling gap by a systematic review of existing sting literature on agile software development methodologies.	It proposes a definition and a classification of agile software development approaches. Second, it analyses ten software development methods that can be characterized as being "agile" against the defined criterion	It compares these methods and highlights their similarities and differences. Based on this analysis, future research needs are identified and discussed.
Al Hamed, and Alenezi, (2016).	Agile Software Development Methods: Review and Analysis	To design and develop the maturity model for BCM DR programs that can be used for measuring the capability of business continuity.	This study uses the thematic analysis	The study results showed a maturity model marked by the two dimensions, along with the company mature.
Alahyari, et al. (2017).	A study of value in agile software development organizations	This paper presents an empirical study investigating how value is interpreted and prioritized and how value is assured and measured.	Data was collected through semi-structured interviews with 23 participants from 14 agile software development organizations.	The contribution of this study is fourfold. First, it examines how value is perceived amongst agile software development organizations. Second, it compares the perceptions and priorities of the perceived values by domains and roles.
AlBar and Hoque (2019).	Factors affecting cloud ERP adoption in Saudi Arabia: An empirical study	This study examined the factors that influence the adoption of cloud ERP in the Kingdom of Saudi Arabia by combining the Diffusion of Innovation theory (DOI) and the Technology-Organization-Environment (TOE) framework.	The study found that a competitive environment, complexity, ICT infrastructure, observability, relative advantage, regulatory environment, ICT skill, and top management support had a significant influence ($p < 0.05$) on adopting cloud ERP. In contrast, compatibility, organizational culture, and trialability had no significant ($p > 0.05$) impact.	This study's findings will offer practical guidelines to the successful adoption of cloud ERP in Saudi Arabia and assist other developing countries in similar circumstances in planning and up-taking cloud ERP services.
Albliwi et al. (2015).	Critical literature review on maturity models for business process excellence	This paper has reviewed the most common maturity models, such as Bessant's continuous improvement capability model, Capability Maturity Model (CMM), and Capability Maturity Model Integration (CMMI).	The authors have observed a lack of maturity models for process management.	Therefore, this research aims to develop a maturity model for a specific area in process management, which is Lean Six Sigma (LSS), as this is the main area of interest for the authors.

3 Methodology

There are two stages in the investigation process: preliminary studies and additional studies. The advanced search process consists of three sub-processes: 1) review the references of the feasibility studies selected to find relevant articles, 2) examine the summaries of feasibility studies selected to find related articles, also called backpacks, 3) identify and contact the author of the main study selected for the unpublished work. Note that the detour search and search selection process is repeated until no new searches are found (Begosso et al., 2019).

3.1 The SR Criteria

The System Review (SR) criteria of the article are to implement the sustainability of the software program (sustainability of any element/sub-element and defined in many quality models) to predict and provide the following elements and to discuss sustainability (any element/sub-element and type of sustainability defined in many quality models) software program metrics or indicators and check the results with experience. This excludes all studies concerning the prediction or measurement of the quality characteristics of sustainability (e.g., forecasting errors, etc.) or the prediction or measurement of maintenance rather than sustainability (Behutiye et al. 2017).

3.2 Study Selection

The study selection phase involves two processes: initial selection and final selection. At the initial stage, the authors reviewed three possible study names and summaries based on the inclusion/exclusion criteria. For almost 30% of people, they cannot decide based on the title and summary alone, as these articles do not make a clear distinction between maintenance and sustainability forecasts. In this situation, the last option is to review the whole text for a decision. After this phase, a total of 14 studies were selected. As shown in Table 1, this figure was obtained after the original investigation. The second search examined references and citations from 14 selected studies and thus added five other studies. One study did not meet the differentiation criteria and was excluded. Of the remaining four, three did not score well in the quality assessment and were also excluded. A total of 15 studies were then selected (Behutiye et al., 2017).

3.3 Study Quality Assessment

For study quality assessment and make a quantitative and qualitative list. The quality list is a way to assess the quality of selected studies and can, therefore, be used as the weight of evidence in answering research questions. These checklists may also provide additional criteria for participation in studies, as very low-quality checklists are excluded as they cannot provide reliable evidence. None of the researchers selected was qualitative, so only quantitative checklists were used to evaluate the studies. The list is based on the questions that (Francis et al. 2010) arise and are presented according to our needs (Benbasat et al., 1987).

3.4 Data Extraction

The first author extracts the data from all selected studies and compares them with the third author's data and the subset of the selected studies to check the consistency. Processed data samples can be obtained from Benbasat et al. (1987). If the study does not require data, contact the author if possible. If he cannot be contacted or no reply is received, it will be registered as a secure reply. For example, none of the selected studies answered the quality question, "Can potential confusions be analyzed?" Only one pardoning author answered, so enter the rest of the search as "partial" answers.

3.5 Analysis of Data

In this study, thematic analysis was chosen for conducting the analysis. This outlines the essential steps that need to be followed for executing this type of analysis successfully. As such, the research approach needs to be framed based on obtaining information. Basic codes were gathered, and a paradigm for the research was formed (Braun and Clarke, 2006). Through this procedure, themes were understood, and finally, the researcher could prepare the overall report. Thematic analysis is prepared based on the perception and judgment of the respondents.

Here also, participants' ideologies and behaviour for this specific topic were gathered to create a theme. For generating viewpoints, a transcript was formed for the chosen interviewees. Both verbal and nonverbal views were gathered in this particular case (Brhel et al., 2015). Through a detailed judgment of all transcripts, the researcher was e able to raise codes and significant themes. These generated new themes that were compared with the existing theories and articles. For increasing the study's reliability, individual statements of the respondents have also been mentioned in the analysis section. This study will be implementing qualitative research analysis data to analyze the data.

3.6 Research Ethics

To gain a positive outcome to a research approach, significant ethical guidelines should be followed. The researcher focused on proper ethical criteria before collecting information from the chosen respondents (Brhel et al., 2015). Ethical approval was taken from two places. First, approval was obtained from the university, and later, companies also showed their endorsement of this research. After obtaining these two permissions, IT professionals were selected to share their views (Heikkilä et al., 2015).

Consent was taken from participants by disclosing the facts and importance of this research. None of them was forced or coerced into sharing ideas, and they were made aware of the probable consequence of research outcomes so that no doubt should be present in their minds. A set of questions were asked of respondents, and for each one, they had the option to skip could withdraw their participation at any point in time. Personal details were not requested; confidentiality and anonymity measures were taken care of properly so that interviewees did not have to experience and backlash (Hoda et al., 2017). After obtaining information from the target participants, data was

properly preserved on a computer drive, which was password-protected, and the researcher only had permission to access it. The researcher is confident that the research study has been conducted with sincerity, maintaining all ethical guidelines.

3.7 Data Analysis

Aggregate data are created by recording the results of each survey question. The following sections discuss the results of each research question. Due to lack of space, this article may not provide an exhaustive summary of each publication. The study results showed that measurement is the essential field in Software engineering as it permits the companies to obtain accurate estimates related to the cost, deadline, and quality of the software projects developments. Also, different tools are easily available for the storage and calculation of the metrics. Thus, selecting the best accurate tool is a hard task for companies. This is why the companies face issues in selecting, so this study carried the measurement tools analysis presented through a Systematic literature review. As the methodology selected for the study, systematic literature review. This study presents the select metric tools in the literature, their metrics, and the functionalities utilized by the tools. Furthermore, this study's main contribution is to make a list of metrics used by the tools and the classification respective as per the use in the software industry.

Measurement in software engineering is an ongoing process in the software development process to define, collect, and analyze data to understand and manage it. This means that by measuring, discovering, and analyzing useful information, people can know how the process is going, produce results, and learn to manage the process to make the process better.

Hsu (2019) proposed one classical definition: he said that the property of real events assigned to numbers by objective experimental activity is a measure of their description. Karim and Rampersad (2017) classified measurement by assigning numbers and symbols to actual properties to describe them according to clearly defined rules. Based on these basic concepts, it can be said that the purpose of the measure is to describe the numerical characteristics of actual objects and events. Kasisopha and Meananeatra (2019) has emphasized that measurements are necessary for the development of science as a whole. Scientific progress will be achieved through observation and development based on data and measurements. The same is true of software engineering in that metrics play a vital role in an organization's success because this metric process allows the software team to manage its capabilities.

Therefore, reliable project plans can be implemented through measurement and do not exceed completed plans in terms of project scope, quality, risk, and duration, as measurement allows people to do so "to gain knowledge of the process. Also, software projects have many measurable functions, Kaur and Kaur, (2015), which reinforces the importance of measurement. Software measurement is a way of pricing / measuring certain aspects of development compared to other projects. These values need to be evaluated correctly. Otherwise, they do not give accurate measurement results and may lead to inaccurate estimates, etc.

The measured values are generally distributed. In this type of scale, the term is a scale where the measured value indicates the order of precedence. The mathematical function of this scale is not used. Period On this type of scale, the term classification is when the measured values keep equal distances instead of ratios. This type of mathematical operation (such as addition and subtraction) is acceptable, but multiplication and division are not allowed. Ratios are the concepts of classification and differences in values on this type of scale. Also, the ratio is the same. The value zero does not match any of the attributes. This type of scale allows all arithmetic operations. Only several physical factors can be measured on this type of scale (Mahalakshmi and Sundararajan, 2015).

Given Saudi companies' position, you need to continue developing the industry if you are to set a successful goal. However, the Target Problem Indicator (TMI) philosophy needs to be used to design indicators for the effective implementation of the indicator system (Begosso et al., 2019). The GQM pattern is understood as a GQM measure that addresses all issues identified in the Software Development Quality Policy (SDQP). By deciding to meet the Saudi language environment's business requirements, some typical goals are successfully achieved. Improving project plans with error management, reliability, and effective thinking is the basis for success indicators in the field. Customer service can be improved by reducing process costs, which can also predict software defects' fate (Abrahamsson et al., 2017).

The software method covers the area recommended for defects and quantities after delivery. The use of plans, plans, customer issues, and cost inconsistencies creates measurable overall reliability for all software.

As software development was identified as a key element of the entire engineering industry, people have made more efforts to take advantage of these areas. Thanks to the last decades in Saudi Arabia, large companies have achieved better results over overtime. With the change of labels in recent years, measurement changes have become software development's main activity (Bryman, 2012). As said in the interview, employees of Saudi Arabian companies are changing software development and measurement methods. Model Capability Development (CMMI) has proven to be effective for software engineering schools and should have a level of development of 2. Handle software ads in the usual way based on software. There are several benefits to deploying this software. Numerous management decisions are made over the software's life, and Saudi Arabian workers are increasingly supporting those (Acosta et al., 2015).

Al Hamed and Alenezi (2016) stated that you rely heavily on the data you expect when you put a programmer into a rigorous software process. This is due to the traditional software development method, which here refers to the waterfall development model. Recently, the spiral model (also known as a logical, unified process) has been highly dependent.

However, employees made it clear in their responses that new software needs to be developed by the century's turn. It is through the ideas of the "flexible manifesto" that serious consequences have emerged. We find that the agar approach is less reliable in documents. In this

case, due to the demands and requirements of traditional methods and the low emphasis on the production of strict documents, there is a tendency to select employees automatically. It is now common to use increased results instead of traditional methods (AlBar and Hoque, 2019). The basics of traditional software development are efficient, reliable, and flexible. In the interviewees' responses, employees and managers clearly stated that flexible and flexible software design is more productive than the traditional software method.

Alexandros et al. (2017) stated that it is important for the companies to undertake the theoretical measures where the overall productivity will be maintained to determine the quantitative measure. There are many mechanisms of software undertaken with the application of the metrics in the undertakings of industry. Moreover, the distinctive shifts in the various direction are developed within the practices of the workplace. According to ALresheedi et al. (2018), software practices are particularly laid in a specific manner adhere to that a certain value-added proposition would be created. The acquisition of the productive techniques of programming requires to be embedded with the metrics of codes.

Also, the software metrics are importantly programmed to investigate roadblocks across particular projects. There are many other software metrics programs to implement effectively so that the organization will develop a higher level of CMM functions. However, many other roadblocks developed with a particular project across the metrics programs are associated efficiently.

4 Conclusion

From a theoretical point of view, this study would bridge the gap in the lack of literature within Saudi Arabia regarding metrics used by Saudi companies. Practically, there are several stakeholders (managers, engineers) who can benefit from this research. Managers can use this research to underline the types of metrics that suit their companies in their persuasion to fulfil competitive advantage in the market. Moreover, engineers can use this research to update their knowledge about the best practices in Software Metrics in Saudi Enterprises. The study results showed the use of the agile method of Scrum in Saudi enterprises, which is a framework for addressing complicated adaptive problems to deliver products with the highest possible value. The method of scrum is simple, and the entire process is result-oriented. That is why various mid-sized organizations tend to adopt this method of software development. It divides the development process into small intervals, which makes this process highly functional in nature and result-oriented. However, within Saudi Arabia, there is low reliance from the decision-makers in the organizations on using software metrics, and the main reason for this is the relatively new background of this subject. Based on this, the authors believe that this research in progress will provide a valuable result that contributes to the literature and understand the agile method's current use by different Saudi enterprises.

The study showed that software metrics allow managers of Saudi Arabia to manage resources more efficiently, making the entire team more efficient. Some examples of metrics include sizing,

such as source byte size, code lines, action tips, GUI operations, and others are production plans, such as production methods that can be used to measure project scope, cost, workload, product quality, as well as to evaluate the quality of the processes used and personal productivity. There are some things to consider when comparing different tasks with the help of measuring tools. If the task is written in another language, the number of code lines may be very different, or larger tasks may have more errors and mistakes. Criteria, such as practical recommendations, provide better guidance than actual project methods rather than a series. Measurements are organized values or categories mapped to a database where measurement results and lessons learned are stored. Weights and dimensions can be divided into five main types: denomination, denomination, denomination—normal time, absolute percentage. In principle, on this type of scale, there is no definition of properties between classes from the concept of order.

5 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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