PROSPECTS OF AN ENHANCED AGILITY ASSESSMENT MODEL FOR LEGACY INFORMATION SYSTEMS

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Abstract

It is necessary for an organization to know when to end the lifecycle of its legacy information system once it is no longer able to accomplish and conform to the modifications the organization needs. Prolonging the length of an information system lifecycle could lead to a decrease in software cost. Consequently, there is the need to develop an assessment model to determine whether or not to continue with the existing information system. However, most of the various metrics and models presented in literature and the researchers' evaluation methods are qualitative and are evaluated by domain experts subjectively. The results obtained will therefore be imprecise. We adopt a quantitative metrics and model methodology to get a more accurate measurement of legacy information systems. This study developed an enhanced agility assessment model to measure legacy information systems with the agility factors: Speed, Robustness, Complexity and Technical skilled personnel. The developed model will resolve the flaws of the existing metrics and models as a result of the quantitative methodology and objectivity of the proposed model.

Keywords: Agility, Software metrics, Legacy Information System, Agility Assessment Model.

1. Introduction

There is no standard definition of a legacy information system (Verbaan, 2010; Crotty & Horrocks, 2017). Ageing information systems that remain in operation within an organization are usually referred to as legacy (Chen and Rajlich, 2001; Furnweger et al., 2016). A legacy information system is any information system that significantly resists modification and evolution (Brodie and Stonebraker, 1998; Bisbal et al., 1999). Lioyd et al., (1999) expanded the definition of a legacy system to include business processes. According to Verbaan (2010), a procedural programming paradigm can also be referred to as legacy. We defined a legacy information system as an information system that has been in operation for some years and runs on a procedural programming language paradigm. The notion of agility is not new, but there is no rigorous or complete definition of agility (Dahmardeh and Pourshahabi, 2011). The term "agile" explains the amount of quickness and responsiveness of an organization in dealing with its internal and external events (Qumer and Henderson-Sellers, 2006). Agility is the ability of an organization to respond quickly and successfully to change (Chandna and Ansari, 2012; Nwokeji et al., 2015). We see agility as the ability of an organisation to meet or satisfy agility factors' metrics benchmark requirements. Deciding the moment to end the life cycle of an information system is often not thoroughly researched. The decision to move on to a newer information system is therefore not always sufficiently justified as the older information system might still be able to perform and comply with the changes the enterprise desires. Prolonging the length of an information system lifecycle could result in

cost reduction in an application portfolio (Verbaan, 2010). Most of the research work on measuring legacy information systems agility has been theoretical or qualitative such as the adoption of a fuzzy approach and analytic hierarchy process (Wang, 2007; Fasanghari et al., 2008; Jassbi et al., 2010; Shahrabi, 2011; Chandna and Ansari, 2012; Nazir and Pinsonneault, 2012; Avazpour et al., 2014; Kumar et al., 2016). The limitation of the fuzzy logic approach, besides being qualitative, is that membership functions of linguistic variables depend on the managerial perception of the decision-maker. Therefore, the decision-maker must be at a strategic level in the company to realize the importance, possibility and trends of all aspects, such as strategy, marketing and technology in the measurement of legacy information systems agility. Given the qualitative evaluation approach and the subjectivity, the results obtained will be imprecise. Verbaan's (2010) work that was quantitative only considered intrinsic agility factors. They appraised different types of intrinsic agility factors by selecting quality, pro-activity and flexibility agility factors with their corresponding software metrics. Extrinsic agility factors were not considered. Our developed model will resolve the flaws of the existing metrics and models by extending and enhancing the work of Verbaan (2010) to include both intrinsic and extrinsic agility factors. The assessment model will be used to identify and address potential areas in the legacy information system that would need improvement. This will increase their ability to change and remain competitive in a dynamic environment.

II. Existing Research Works of Legacy Information Systems Assessment

Jin et al., (2007) work on legacy information systems was on database-centric information systems which often process a large amount of data with stringent performance requirements. Their work focused on performance evaluation and prediction for legacy information systems when they are subject to dramatic increases in workload and database loading. Their approach combines the use of benchmarking, production system monitoring and performance modelling. Gandomani and Nafchi (2014) presented a model to measure the agility degree of agile software companies. The proposed model can compute the Agility of an organization based on the adopted practices in that organization. This study identified the importance of agile practices in being Agile. The foundations of the proposed model are agile practices and their importance in achieving agile values. Their work focused on the software development process. Bakar et al., (2018) legacy information system assessment model focused on the public sector. Their research adopted a qualitative approach which incorporates the theoretical and empirical phases. The theoretical phase was conducted by analyzing existing literature on the information system assessment models and methods which are the ISO 25010, ISO 25012, Hierarchical Model and Renaissance Method. The empirical was conducted by employing interviews with informants that were involved in the use of the legacy information system. Data from the theoretical and empirical study were analyzed using content analysis. Verbaan (2010) proposed a method of assessment for legacy information systems and identified possible areas in which a legacy information system would need enhancement to increase this capacity to change. He studied different categorizations of metrics by selecting flexibility, quality and pro-activity as agility factors with the corresponding metrics. He did not consider Technically skilled personnel because it was out of the scope of their research work. Also, speed was not selected as they believe it is a subset of flexibility. Strohmaier and Lindstaedt (2011) perceived flexibility to be a rather commonly passive characteristic. Verbaan (2010) used MTTF for a repairable software product instead of MTBF which is the metric adopted for a repairable product (Speaks, 2005; Heiser and Hofmeister, 2019). Edegbe et al., (2013) paper titled "Overview of Software System Agility Assessment Models" expands the agility factors proposed by Verbaan (2010) to include innovation, but legacy information system is not innovative (Verbaan, 2010). Qumer and Henderson-Sellers (2006) opined that agility can be measured in terms of the five variables

or (features) namely: a. Flexibility (FY), b. Responsiveness (RS), c. Leanness (LS), d. Learning (LG) and e. Speed (SD). They developed a mathematical model:

DA (Object) = (1/m) Σm DA (Object, Phase or Practices) to assess the degree of agility (DA) (at both phase and practice level) in one of the agile methods:

Extreme Programming (XP) built on the five variables above. Wang et al., (2007) specified that some of the various metrics presented in the literature such as Cost, Time, Robustness and Scope of changes (CTRS) and Simplicity, Speed and Scope of changes (3S) and the researchers' evaluation methods, e.g., Analytic Hierarchy Process (AHP) and Fuzzy Mathematics used to integrate these metrics to get the final results are qualitative and usually need to be assessed by domain experts subjectively. The results that will be derived will not be accurate. To solve these deficiencies above, Wang et al., (2007) presented an agility evaluation method called propagation graph and reachability matrix to precisely measure agility for CBS. The limitation is that the method is somehow complex. Imache et al., (2012) extended the work of Izza et al., (2008). They proposed fuzzy logic-based assessment methods to assess, regulate and preserve continuously the Information System agility. They also proposed a prototype implementation and an application of the proposed approach to a tour operator enterprise. Their use of the POIRE framework was based on two main principles: Urbanization and continuous improvement. The limitation of the presented model is that it neglects the mutual interaction between the different dimensions' factors and criteria of the enterprise information system. Therefore, the obtained results of the agility are not essentially the best ones. Also, their work mainly focuses on agile information systems rather than the technological perspective. Trabelsi and Abid's (2013) work was equally on Urbanization. They proposed an urbanization framework that aims to simplify the information system by improving communication between its components and ensuring its evolution. In an exploratory approach, the study examines the state of urbanization of information systems in Tunisian companies and verifies the agility of urbanized information systems (UIS). This was done to ascertain the evolution of information systems and guarantee the agility in facing environmental turbulence. However, this study has several flaws. In the first case, the sample size of the study was limited to only private firms in Tunisia. The generalizability of the results may be limited because of the small sample size when compared to the overall population, including the SMEs in other studies. Second, the number of variables used in this study is also limited to agility, interoperability and flexibility. Rathor and Batra's (2016) research was on "Tradeoffs between Delivery Capability and Agility in Software Development". They developed a structural model to assess the effects of delivery capability and agility on software development success and also quantify the effects of antecedent process variables on delivery capability and agility. To test the research model and hypotheses, survey data was collected using an online questionnaire from IT professionals that have adopted agile methodology for software development. Partial least squares (PLS) were used to evaluate the survey data. Jassbi et al. (2010) developed a new approach based on the Adaptive Neuro Fuzzy Inference System (ANFIS) for evaluating agility in the supply chain. They considered agility capabilities such as Flexibility, Competency, Cost, Responsiveness and Quickness. The absence of an efficient assessing tool for the agility of the supply chain system made them develop a procedure with the above-mentioned functionality. The vague nature of qualities for associated concepts convinced them to apply fuzzy concepts. They combined this powerful tool with Artificial Neural Network concepts in favour of gaining ANFIS as an effective and efficient device for the development and surveying of their unique procedure. Kumar et al. (2016) work commenced with the development of a Supply Chain Agility Assessment Model in a manufacturing organization. The model is comprehensive as it includes Five Enablers

and Twenty-Two different Agile Supply Chain Criteria and various Agile Supply Chain Attributes. The Fuzzy logic approach was used to evaluate the Supply Chain Agility. The output of the Project included the Supply Chain Agility Index, Fuzzy Performance Important Index of Various Agile Supply Chain Attributes and Identification of Principal Obstacles. The improvements for supply chain agility improvement were derived from within the company. The implementation of the results led to enhancement of profitability and an increase in the customer domain of the organization. Nazir and Pinsonneault (2012) work investigated the link between IT and firm agility through an electronic integration perspective. The electronic integration perspective framework suggests that IT applications affect the sensing and responding components of agility through internal and external integration. The framework also describes the mediating roles of knowledge exploitation, knowledge exploration and process coupling. Chandna and Ansari (2012) recommended fuzzy inference systems (FIS) that are designed in several steps: fuzzification, aggregation of antecedents, inferencing, composition, and defuzzification for assessing agility. The weaknesses of this fuzzy logic method are that the membership functions of linguistic variables depend on the managerial perception of the decision-maker. Shahrabi's (2011) work also used fuzzy logic as a tool to evaluate their agility assessment model called the Grason model to determine the agility of an organization and its relationships. Avazpour et al., (2014) developed a framework based on the fuzzy multiple criteria decision-making approach to identify the most appropriate agility enablers to be implemented by companies. Using fuzzy logic to address the ambiguity in agility evaluation, the fuzzy Prioritization Method was applied to determine the weights of the agility attributes as their criteria. A similarity-based Approach was adopted to rank the agility enablers as their alternatives. The framework was implemented in a real case involving a subsidiary company of the National Iranian Gas Company. The proposed framework helps the company to concentrate on the most effective enablers and develop strategies to implement them based on their priority. Aggoune et al., (2012) extends the concept of agility to the e-government field through an evaluative framework for the measurement of e-government information system (E-GIS) agility. The key idea of this framework is to combine the fundamental parts of E-GIS with their operational parameters to evaluate the overall agility of the system. One of the benefits of this practical framework is that agility parameters are assessed with the help of quantitative metrics, which allow decision-makers to inspect and compare different systems at different agility levels. The evaluated framework presented is only theoretical.

III. Methodology

A developed online assessment system, related and relevant to the software agility factors-Technical Skilled Personnel, Complexity, Robustness and Speed are proposed for the implementation of the developed enhanced agility assessment model. The stand-alone online assessment system will be based on the validated relevant software metrics and validated test questions. The software metrics and test questions are expected to be validated by domain experts in the field of Computer Science, Information Systems and Software Engineering to determine their appropriateness. The domain experts will be drawn from the academic and the industry. The Metrics and Test questions for validation are derived from extant literature and will be rated in Likert format from 1 to 5 based on the relevance of the Metrics and test Questions to the subject matter. The Input parameters for the assessment system will be from the validated test questions, interrogated case study legacy information system and the source code. The test questions will be relevant to the application program running the case study legacy information system. The output from the online assessment system will be compared with the adopted benchmark metrics from the literature. When the results from the online assessment system satisfied the agility factors' metrics benchmark

requirements, it shows that the student information system is agile. It can still cope with the changes the organization desires.

IV. Results

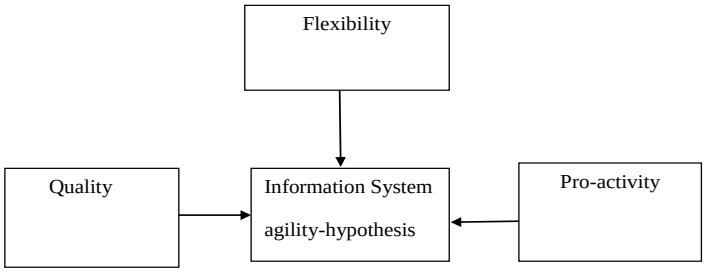

Figure 1: Agility Framework for Legacy Information System (Verbaan, 2010)

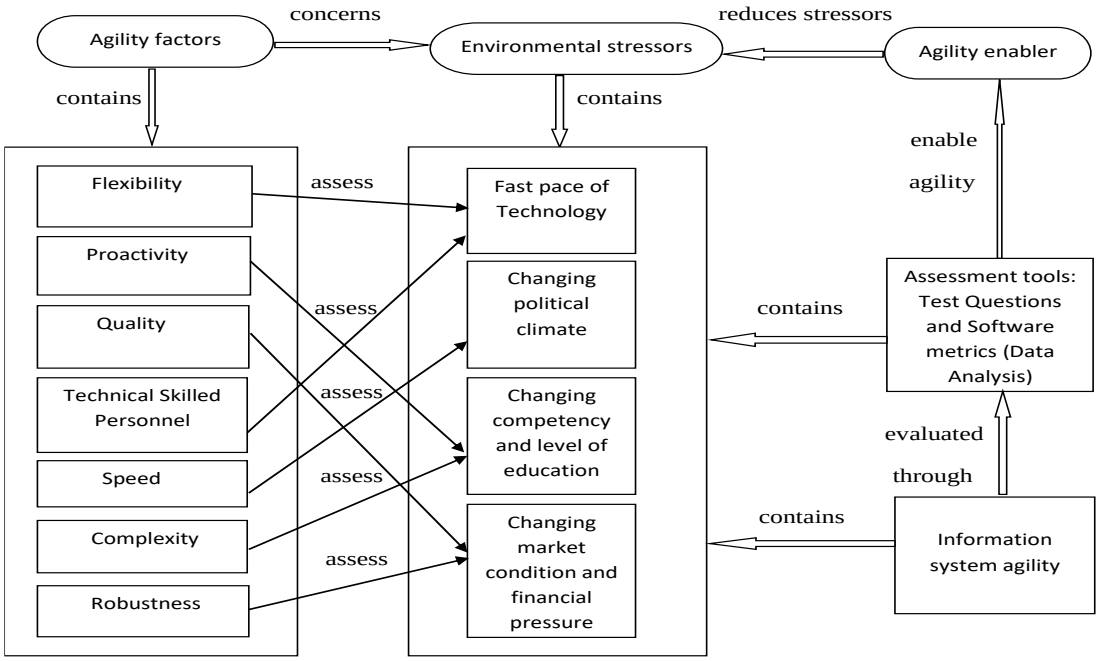

Figure 2: The Proposed Enhanced Agility Assessment Model

There is increasing recognition that agility, technical skilled personnel and information systems are important for the success of contemporary firms as they face intense rivalry, globalization, and time-to-market pressures (Edegbe, 2015; Felipe et al., 2017). The problem with the existing models is that most of their evaluation methods are subjective. Evaluation methods such as propagation graph and reachability matrix adopted for Component-Based Systems (CBS) are somehow complex. Our proposed enhanced agility assessment model evaluation method which makes use of software metrics is quantitative. It includes intrinsic and extrinsic agility factors which will therefore produce a more accurate result. The enhancement is about its features, correctness, reliability and effectiveness. When the legacy information system satisfies the given agility factors metrics benchmark, it is said to be Agile. According to Kurian (2011) being agile means satisfying given agility factors. Technical skilled personnel, Speed, Robustness and Complexity agility factors with their related metrics, can be used to assess the environmental factors that necessitate the need for organizational agility. Verbaan's (2010) intrinsic agility factors framework in figure 1 was expanded to include both intrinsic and extrinsic agility factors in the development of our enhanced agility assessment model for a legacy information system. Verbaan's (2010) work considered speed as a subset of flexibility, but Strohmaier and Lindstaedt (2011) opined that flexibility is generally a passive characteristic. Verbaan (2010) also adopted MTTF for a repairable software product instead of MTBF which is the metric used for a repairable product (Speaks, 2005; Chauhan and Pancholi, 2013). Consequently, our model is presented in Figure 2. Some of the environmental factors are fast pace of technology. New technologies roll out regularly. There are situations where an information system of two to three years in operation is already a legacy system due to the fast pace of technological innovation. An information system that is flexible and with highly technical skilled personnel, can cope with the fast pace of technological changes. The consistency in the speed of an information system will minimize the adverse effect of the changes in the political climate. Changes in political climate affect the survival of an information system. A new government in most cases comes up with new policies which result in environmental instability. As information systems are becoming more complex, management in organizations needs to be proactive in responding to changing competency and level of education of its Staff. Organizations need to constantly determine the level of staff competencies in the ever-dynamic environment where there is high staff turnover, especially the technical one. Regular training of staff is not enough. There is the need to constantly measure their level of competence to fill the skill gap either from within the organization or outside the organization. Moreover, filling the technical skill gap is a long-term process. Also, a robust and high-quality information system will be needed to cope and adapt to changing market conditions and financial pressure. For an organization to survive, they have to consistently meet up with changing consumer taste. When our proposed enhanced agility assessment model in figure 2 is implemented, we should be able to determine when to end the lifecycle of the legacy system or move on to a newer information system.

V. Conclusion

The result of our developed enhanced agility assessment model when implemented will indicate the agility status of the legacy information system, provide insight on whether to move on to a newer information system or not and what to improve to gain agility and increase its ability to change. Our future research work will centre on the validation and the implementation of the proposed model using a student information system as a case study.

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