Assessment Risks for Managing Software Planning Processes in Information Technology Systems

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Abstract

This study is aimed to apply statistical modelling approached to minimize risks software planning process by using fuzzy and stepwise approach. The fuzzy approach model’s accuracy slightly enhances than stepwise approach. However, all approach modeling risks were an acceptable value for the mean magnitude of relative error (MMRE) including prediction at level (25). Indeed, this study used the evaluation techniques (MMRE, Pred (l)) to validate good prediction and estimating the predictive level to produce two scenarios. This study provided empirical evidence to identify and model software issues and controls that effect on successful planning processes. Besides, the data gathered from the software projects and top IT managers at Palestine software development companies can be used in modeling.

Keywords: Planning Process, Software Risks, Risk control Techniques, Fuzzy and Stepwise approach, Information Technology Systems

1. INTRODUCTION

Risk management is a risk handling practice and it contains methods including processes and tools to manage software projects risks in order to prevent it from being a problem [1]. Thus, the purpose of software risk management for analyzing the possible risks before it occurs. Hence, the appropriate risk reduction strategies have become a plan and been applied as required during the software development life cycle in order to reduce the risk of software [2]. Unquestionably, implementation of risk management increases firm value, reduces debt costs, increases profits, and increases decision making [3]. Although, many software projects are risky and are often are considered out of control, as they do not meet budget expectations and schedules. Moreover, risk management has been considered as business practices in emerging and developed countries which is an under-researched area [4]. Thus, this risk management objective aimed to identify including recognizing the risks in the initial state including exchange the actions route in order to reduce the risk [5]. Additionally, cloud security has been regarded as a wide subject and it can also be a mix of technology, policies including
controls in order to protect infrastructure, data, and services from possible attacks or achieve business objectives [6]. There are several models and method to reducing the risks in software development projects that has been grouped to three categories which are qualitative, quantitative including smart approaches [7]. The objectives are: to evaluate and compare prediction accuracy between fuzzy and stepwise approach models by using the mean magnitude of relative error (MMRE) and prediction at level (25) in order to identify issues and controls which lead the software project managers to reduce it in software planning processes project.

2. LITERATURE REVIEW

“Elzamly and Hussin” made the improvement related to the software project quality by participating companies when estimate the which is risks affected the quality in IT software projects. Khanfar et al. [1], new techniques applied chi-square ($\chi^2$) measures to monitor risk in software projects. Although, the new method has been implemented which are regression tests and also proposed impact size tests to manage risk in software projects including reduce risk with improved software processes [2]. The [11] introduced a model related to linear stepwise discrimination analysis to assume software risks in the process of software development analysis. This method has been implemented to evaluate and estimate risk through applied control methods. Furthermore, according to [3] cloud computing is a new technology that every organization today wants to adapt to its business for more scalability and profit. Additionally, a new stepwise regression methods has been applied to handle the risk in software projects. As mentioned in [13] this test has been performed to specify whether its effect in reducing the occurrence in every factor of risks in the implementation stage by comparing the controls for every factor of risks in regression analysis. The study [14] had proposed a new technique in order to certify whether fuzzy and stepwise regression is successful in reducing the software risks factors occurrence in the phase of implementation. The purpose of this paper is to propose a new technique to determine whether fuzzy and stepwise regression are effective in mitigating the occurrence software risk factor in the implementation phase. It also presented [15] the new techniques applied fuzzy multiple regression analysis methods with the idea of fuzzy which to handle the risks of software in a software analysis project and reducing risk with software analysis process enhancement. Referred [16], the research has been conducted in mining and qualitative method which comparing the risk management methods to every risk in software maintenance in order to recognize including modeling if it effectively reducing the occurrence of every risks in software maintenance in software development life cycle (SDLC). Besides that, an artifact model of software risk management for reducing the risks had been proposed which consists of five tiers in risks mitigation via software project [4]. Others than that, the factors analysis method for determine and categorize the risk management methods in software development project been described [5]. Because of existence of risk management in monitor the successful of a software project, analyzing potential risks including decision making related to what to do as well as potentials risks the software development projects still been considered failed to transmit the acceptable systems in the time that been estimated with the budget. As mentioned in [6], risk management is a planned control of risk and integration of formal risk management between the project management been considered as a new phenomenon in software engineering and product management.
community. However, as mentioned in [7] the positive assumption of the cloud security critical issues is leading to surging the probability of cloud in banking success rate.

Lastly, there are several stage in risk management technique which are risk identification, risk planning, risk prioritization, risk analysis, risk evaluation, risk treatment, risk controlling, risk communication including documentation depend on the three categories such as risk qualitative analysis, risk quantitative analysis and risk mining analysis through the life of a software project to reach the goals.

Planning process: A review

This section is discussing the top ten software processes issues in software development planning process and subsequently required to be controlled [8]–[10].

**Risk 01: Low key user involvement.**
Lack of user involvement is one of the major risks [25]. It is important to meet user expectations; thus key users should be convinced of the system utility. In addition, software project deliverables should be consistent with user perceptions. In this issue where failure to do so, will lead to incomplete, inconsistent, and incapable to satisfy meeting user expectations [26].

**Risk 02: Unrealistic schedules and budgets.**
Two major risk areas as unrealistic schedules and budgets are another in the software project risk [27]. It is understood that the changes in schedule and developing time estimated are inaccurate or too low and unreasonably low cost. Furthermore, the software project is unable to recognize its objectives to set unrealistic restrictions on the software projects budget for successful software project [28].

**Risk 03: Unrealistic scope and objectives (goals).**
Ewusi-Mensah (2003)[27] stated that unrealistic software project scope and objectives are another critical. Generally, the new changes of scope and objectives in the software development process are introduced with the knowledge misunderstand by software project management [29]. Thus, it will lead to changes in the requirements software project, probably add extra cost, and will extend the system delivery.

**Risk 04: Insufficient/ inappropriate staffing.**
There is insufficient staffing in the software project, which deals with issues in the distribution of responsibilities, roles and inexperience, and training for the software project team as reported by [30]. In general, it returned to limit the communication plan within the team, thus the software project team was unaware of the users’ requirements and expectations [31].

**Risk 05: The senior management commitment and technical leadership deficiency.**
Direct senior management commitment is expected to influence the successfulness of software system adoption as reported. However, the risk of a software project may occur when technical leadership in a software project is poor. According to Rudd [32], it is very difficult to achieve success with service management initiatives if there is a shortage of senior management commitment. This is because, while the software manager has insufficient leadership skills and experiences, he is unable to perform his tasks, control tools, and communication plan.

**Risk 06: Poor /inadequate planning**
However, factors of poor or lack of project planning [33] such as identification of business goals and determining the strategic business issues are the essential elements of the planning process [30].
Risk 07: The effective of software project management methodology deficiency.  
This risk involves the inability of the team to employ change control, project planning or other necessary skills in management methodology [34].

Risk 08: Modification in organizational management during the software project.  
It is clearly reported by [35], that change in organizational management occurs through software development project lifecycle in the planning process. This will lead to unorganized or limited access to communication plan and tools of technical analysis to achieve stable organizational management [31].

Risk 09: Ineffective communication software project system.  
Ineffective communication system or language barriers in software project communications is another factor that affects software projects [26]. Therefore, software projects sometimes fail due to incorrect and weak communication [36]. Thus, it is critical to communicate what is happening, including the scope, objectives, and activities of the software project [37].

Risk 10: Absence of historical data (templates).  
Lack of historical data (templates) [2] such as requirements, prototyping, architecture, etc. However, there are no risk templates that help software manager in each of the elements to mitigate risk. By having such a template, it is easy to track the common risk. We also used historical data to predict the risk occurring in the software system, so we need accurate and real data [38].

3. EMPIRICAL STRATEGY

Indeed, we collected data by using a survey questionnaire and used distribution personal regular sampling and snowball sampling methods for distributing it to 76 managers. Furthermore, we used fuzzy approach regression, stepwise approach regression analysis, mean magnitude of relative error (MMRE) and prediction at level (l). Besides, we identified 30 risk controls and methods for mitigating issues [11]–[16].

Quantitative and Intelligent Modelling Techniques

Software risk management needs techniques that are based on intelligence to mitigate risks. Quantitative risk analysis is described as a model to predict the effective size of the software risk from several control techniques to guide the mitigation procedure. To search the relation between software risks and controls, the software projects encountered and the countermeasures that must be done to mitigate the risks, a lot of researchers implemented differ technique of statistical such as chi-square (χ2) technique regression analysis, and so on. Quantitative models could help project managers estimate the risk (for example, estimated probabilities), and hence, managers can make better planning to avoid risks in software projects [45]. The software risks and the methods of prevention of these risks and the necessary actions have been clarified to mitigate the risks from any software development life cycle [46]. In this paper, the stepwise regression analysis model, fuzzy multiple regression model, and method for evaluating such as MMRE and Pred (l) are used. Multiple regression analysis is used to create models that predict software risks and controls. The stepwise multiple regression method has been implemented to select independent variables and to determine the optimizing regression models. In the third stage, multiple regression models with fuzzy concepts after selecting the best controls through the implementation of stepwise. In the final stage, stepwise multiple regression model and fuzzy multiple regression model were compared by
implemented the evaluating techniques and summary. In addition, the concepts of the methods were explained in this chapter below. Furthermore, the method of prediction, stepwise multiple regression analysis, and fuzzy multiple regression analysis has been used to reducing and modeling among the software planning risks. Model findings were compared with the stepwise multiple regression analysis models and fuzzy multiple regression analysis models. Besides, software project risk model’s performance was evaluated by MRE, MMRE, Pred (l) that compared many models of software project risk. These experimental techniques and approaches were conducted to validate good prediction and to estimate the predictive level to produce two scenarios. Indeed, to validate the model, stepwise and fuzzy multiple regression analysis was implemented to create a relation model among risks and controls based on literature and to determine that mitigates risks. This paper has thus enhanced risk management models with a new model to mitigate risks based on input from software managers. In addition, stepwise and fuzzy multiple regression analysis is a linear statistical data model or tools used to model and predict the controls that are useful to mitigate risks. This model has applied the modeling techniques for quantitative risk management approach. The modeling steps for stepwise and fuzzy multiple regression analysis have been discussed in this section.

Regression Analysis Model

Regression analysis techniques are used to predict a sharp relationship among the dependent variable and independent variables. Consequently, a better model could be implemented to predict the relationship between the variables; it can be used to predict the numbers of controls will be useful. Indeed, multiple regression analysis models predict the level of software risk with different combinations of control factors. Obviously, regression modeling can be considered as the most highly implemented in statistical modeling method to meet the response variable (dependent) as a function of predictor variables (independent) [47]. On the other hand, regression analysis is a statistical method for modeling and analyzing the variables. It is used to study the relationship that exists between the dependent variable and one or more independent variables. In addition, the software risk factor has been defines as a dependent variable which control factors (risk management techniques) are independent variables.

Modelling for Regression Analysis Methods

There are several methods for selecting independent variables. These methods allow us to specify how independent variables are entered into the analysis, so it can build a variety regression models such as simultaneous selection procedure, stepwise selection procedure, forward selection procedure, or backward elimination procedure. However, these methods are used to analyze the correlation among dependent variables and independent variables including to reflect on the type of relation by regression models.

3.1.1 Simultaneous Selection Procedure

In the simultaneous selection procedure, all independent variables should enter at once. However, this technique is suitable for small-scaled data.

3.1.2 Forward Selection Procedure method

This procedure begins with a null model with the addition of the independent variable which been considered as the best predictor of the dependent variable (most significant variable). After that continue with checks the coefficient which is significantly different from p-value by at least 0.05. Then proceed with adding others which increase the
predictions most often, subject to the criteria, typically the coefficient is far different from zero at the 5% level. The process continues until no other variable meets the specified criteria [17].

3.1.3 **Backward Elimination Procedure method**

This procedure starts with all independent variables in multiple regression models followed by the removal of the smallest t-test with the condition that p-value is at least 0.05; the process continues until no more variables are removed; Again, the criteria can be adjusted [48].

3.1.4 **Stepwise Regression method**

Stepwise multiple regression analysis methods are the stepwise optimization process of regression analysis method, which is better in terms of the relationship among dependent variables and independent variables and simulating each type of nature and economic phenomenon with better results. However, it’s integrated and rotate among the forwarding selection and backward elimination. Besides that, the best remaining variables added if it meets the significant at p-value which is at least 0.05 criteria in every step.

Then the independent variables at this time in regression are examined to see if any can be removed, through greater than the critical criteria. The process continues until no other independent variable is added or removed (a set of stable variables is achieved). In other words, stepwise regression analysis systematically adds and removes independent variables based on statistical tests to automatically identify the risks for large-scale data in operations [49]. In the same case, it adds a useful specification when required to make assumptions for variables depending on a large set of independent variables [56]. In addition, Lan and Guo (2008) emphasize that the MSRA technique balances the weaknesses of multiple regression analysis, such as the lack of selecting regression variables manually and by obtaining suitable predictive results in experiments by using stepwise multiple regression analysis. Indeed, stepwise multiple regression analysis is applied for selecting the best independent variables based on statistical criteria with dependent variables.

3.1.5 **Coefficient of Determination**

The determination coefficient ($r^2$) is the proportion of variation in observable values of the response variables described by the regression [18]:

\[ r^2 = \frac{RSS}{TSS} = \frac{\sum (\bar{y} - y_{avg})^2}{\sum (y - y_{avg})^2} \]

**Regression Sum of Squares (RSS):** The variation of the value is observed by the response variable described by the regression.

**Total Sum of Squares (TSS):** The variation in the values is observed from the response variable.
Fuzzy Multiple Regression Model

3.1.6 Fuzzy Concepts with Multiple Regression Modelling

Fuzzy regression analysis is a continuation of classical regression analysis where several elements of the model are represented by a fuzzy number. In the fuzzy multiple regression model, the response variable is a fuzzy variable and part of covariance is a crisp variable [52]. Therefore, the fuzzy regression method is very helpful in expanding the application field of classical regression method in such a way which determines the regression relation for the initial data of fuzzy that could be either quantitative or qualitative [53]. In addition, the same author explains when one or some data points are considerably influenced by random factors, there must be a difference between the results obtained and the real value. At that time, classical regression analysis cannot be used. While actual data tends to be inaccurate, no previous study has developed a mining algorithm to find out the direct knowledge of inaccurate data [54]. Then a questionnaire on the data mining problem had been introduced and the pattern of rules that can be mined from the questionnaire data is defined. Besides that, Unified approaches are developed based on fuzzy techniques so that all different types of data can be operated in a uniform manner [55]. Therefore, in order to discover the rules of the questionnaire dataset, new approaches that can handle the occurrence of different types of data are required [55]. Thus, the same author explains that all types of data can be represented and operated from a fuzzy point of view. Furthermore, the rules of the crisp association must be extended to the rules of the fuzzy association from the questionnaire data.

3.1.7 The Membership Function with Fuzzy Concepts

The fuzzy concept helps us to find the deviation of each data from the fitness equation, thus defining the membership function of the normal distribution as follows [19]:

\[ U_i = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{1}{2} \left( \frac{y_i - \mu}{\sigma} \right)^2} \]

Where:
- \( \mu \) = average of sample points and
- \( \sigma \) = the square root of variance math.

If adding a fuzzy domain to the regression technique, the effect of discrete data points on fitness results would be mitigated and the effect of concentrated data points on fitness results will be enhanced. Indeed, the membership function is a curve that determines how each point in the input space is mapped to a membership value between 0 and 1 [49].

3.1.8 Fuzzy Parameters

The group of equations to get a fuzzy parameter is provided as [58]:

\[
\begin{align*}
    s_{11} b_1 + s_{12} b_2 + \cdots + s_{1k} b_k &= s_1 y \\
    s_{21} b_1 + s_{22} b_2 + \cdots + s_{2k} b_k &= s_2 y \\
    s_{31} b_1 + s_{32} b_2 + \cdots + s_{3k} b_k &= s_3 y \\
    \vdots \\
    s_{k1} b_1 + s_{k2} b_2 + \cdots + s_{kk} b_k &= s_k y \\
\end{align*}
\]

Here
Referred to the group of equations, first, obtain the values of variables \( b_1, b_2, \ldots, b_k \), and finally \( b_0 \) is obtained by:

\[
b_0 = \frac{\sum y}{\sum x} - \frac{b_1 \sum x^1}{\sum x} - b_2 \frac{\sum x^2}{\sum x} - b_3 \frac{\sum x^3}{\sum x} - b_4 \frac{\sum x^4}{\sum x} - \cdots - b_k \frac{\sum x^k}{\sum x}
\]

3.1.9 Coefficient of Determination

Determination coefficients are used to evaluate the quality of the estimation model and expressed by \( R^2 \). The \( R^2 \) coefficient is calculated by [23]:

\[
R^2 = \frac{\sum_{i=1}^{n} (\hat{y}_i - \bar{y})^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}
\]

Here, \( \bar{y} \) state the mean value of a random variable. Clearly, the \( R^2 \) coefficient explains the percentage of variability and value between 0 and 1; when \( R^2 \) is close to 1, it indicates that this model can explain variability in response to predictive variables.

Evaluation Techniques Criteria

In order to verify the model with appropriate accuracy, the Mean Magnitude Relative Error (MMRE) and Pred (25%) was used [25]. Many different approach for measuring a model’s error are available as MRE and MMRE [26]. However, the relative error (RE) was calculated in percentages [25]:

\[
\text{The relative error (RE)} = \left( \frac{(\text{Actual Effort} - \text{Estimated Effort})}{\text{Actual Effort}} \right) \times 100
\]

The usual criteria for measuring the performance of the software business estimates model which calculated for each observation is the magnitude relative error (MRE) and the absolute value of the relative error [61]:

\[
\text{MRE}_i = \left| \frac{\text{Actual Effort}_i - \text{Predicted Effort}_i}{\text{Actual Effort}_i} \right|
\]

The impact of the accurate estimation is assessed via the evaluation criteria (MRE, MMRE) for every model. The mean magnitude relative error (MMRE) is the average of all relative error magnitude. Pred (25%) is a percentage of software projects with 25% of MRE or less [61]. Thus, with the MRE aggregation in all data sets, the mean magnitude relative error (MMRE) is achieved by the following equation:
Therefore, Pred (25) or more than according to the equation been implemented:

\[
\text{Pred} (l) = \frac{K}{N}
\]

Thus, the parameter k is the number of observations where MRE is less than or equal to l, for example, Pred (25) provides a predicted project percentage by calculating the number of MREs less than or equal to 0.25 and dividing by the number of projects. However, estimation technique accuracy is proportional to Pred (25) and inversely proportional to the MMRE. The MMRE are applied in two types of assessments (at least). The MMRE is to select among competing predictive models and provide a quantitative measure of forecast uncertainty [64].

4. **Comparison Between Stepwise Approach and Fuzzy Approach By Using Evaluating Prediction Of Accuracy Techniques**

Table 1 illustrates an evaluation approach models based on mean magnitude of relative error (MMRE) and prediction at level (l). Thus, the fuzzy approach model’s accuracy little bit improves than stepwise approach. In addition, all approach models’ values are desirable.

Table 1: An evaluation and comparison approach models based on mean magnitude of relative error (MMRE) and prediction at level (l)

<table>
<thead>
<tr>
<th>Module</th>
<th>Technique</th>
<th>SMR</th>
<th>FMR</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM1</td>
<td>MMRE</td>
<td>0.116855</td>
<td>0.117943</td>
<td>C6: Implementation and following communication plan, C21: Includes official and periodic risk assessment.</td>
</tr>
<tr>
<td></td>
<td>Pred(25)</td>
<td>0.9605263</td>
<td>0.9342105</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMRE</td>
<td>0.121344</td>
<td>0.123183</td>
<td>C1: Using of requirements scrubbing.</td>
</tr>
<tr>
<td></td>
<td>Pred(25)</td>
<td>0.9342105</td>
<td>0.9473684</td>
<td></td>
</tr>
<tr>
<td>RM2</td>
<td>MMRE</td>
<td>0.1473173</td>
<td>0.1440461</td>
<td>C6: Implementing and following a communication plan.</td>
</tr>
<tr>
<td></td>
<td>Pred(25)</td>
<td>0.8947368</td>
<td>0.8684210</td>
<td></td>
</tr>
<tr>
<td>RM3</td>
<td>MMRE</td>
<td>0.1755641</td>
<td>0.1780400</td>
<td>C6: Implementing and following a communication plan.</td>
</tr>
<tr>
<td></td>
<td>Pred(25)</td>
<td>0.8026315</td>
<td>0.8815789</td>
<td></td>
</tr>
<tr>
<td>RM4</td>
<td>MMRE</td>
<td>0.1421271</td>
<td>0.1454038</td>
<td>C6: Implement and follow communication plan, C16: Implement / Use automatic version control tool.</td>
</tr>
<tr>
<td></td>
<td>Pred(25)</td>
<td>0.8684210</td>
<td>0.8947368</td>
<td></td>
</tr>
<tr>
<td>Module</td>
<td>Technique</td>
<td>SMR</td>
<td>FMR</td>
<td>Controls</td>
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<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>RM6</td>
<td>MMRE</td>
<td>0.119696</td>
<td>0.1215694</td>
<td>C5: Developing and adhering a software project plan, C27: Combine internal evaluations with external comments.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.9210526</td>
<td>0.9605263</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MMRE</td>
<td>0.1279790</td>
<td>0.1290990</td>
<td>C24: Ensure the delivery of quality factors and task analysis.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.9078947</td>
<td>0.9473684</td>
<td></td>
</tr>
<tr>
<td>RM7</td>
<td>MMRE</td>
<td>0.1359396</td>
<td>0.1403567</td>
<td>C17: Implement / Use benchmarks and technical analysis tools, C27: Combine internal assessments with external comments, C25: Avoid too many new functions on software projects, C6: Implement and follow the communication plan.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8815789</td>
<td>0.8947368</td>
<td></td>
</tr>
<tr>
<td>RM8</td>
<td>MMRE</td>
<td>0.1251875</td>
<td>0.1386960</td>
<td>C24: Ensure the delivery of quality factors and task analysis, C27: Combine internal assessment with external comments, C25: Avoid too have many new functions on software projects, C5: Develop and adhering with software project plans.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.8815789</td>
<td>0.8552631</td>
<td></td>
</tr>
<tr>
<td>RM9</td>
<td>MMRE</td>
<td>0.1323598</td>
<td>0.1316198</td>
<td>C4: Build prototypes and have customer-reviewed requirements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.9473684</td>
<td>0.9342105</td>
<td></td>
</tr>
<tr>
<td>RM10</td>
<td>MMRE</td>
<td>0.9210526</td>
<td>0.9605263</td>
<td></td>
</tr>
</tbody>
</table>

5. CONCLUSIONS

The results show that the maximum value of the fuzzy approach model for the MMRE is slightly higher than the value of the stepwise approached model except risk 3, risk 10. Thus, the most frequent value of the fuzzy model for Pred (25) is slightly higher than or equal to the value of stepwise model except risk 1, risk 3, risk 9, and risk 10. As future work, this decision of this study can be used for real-world software projects to validate the effectiveness of a new method approach on a project. Similarly, it is necessary to implement artificial intelligence algorithms and methods to plan risk mitigation in a software project.

6. ACKNOWLEDGEMENTS

This project is performed as part of the Palestine-Quebec Science Bridge initiative. The authors also would like to thank Al-Aqsa University, Gaza, Palestine, University of Quebec Outaouais (UQO), Canada and Palestine Academy for Science and Technology.
7. REFERENCES


