Managing Software Project Risks (Planning Phase) with Proposed Fuzzy Regression Analysis Techniques with Fuzzy Concepts

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Abstract
Regardless of how much effort we put for the success of software projects, many software projects have very high failure rate. Risk is not always avoidable, but it is controllable on software development projects. The aim of this paper is to present new mining technique that uses the fuzzy regression analysis modelling techniques to manage the risks in a software development project and to reduce risk with software process improvement. Top ten software risk factors in planning phase and thirty risk management techniques were presented to respondents. The results showed that all risks in software projects were important in software project manager perspective, whereas all risk management techniques are used most of time, and often. However, these mining tests were performed using fuzzy multiple regression analysis techniques to compare the risk management techniques to each of the software risk factors to determine if they are effective in mitigating the occurrence of each software risk factor. Also ten top software risk factors (planning phase) were mitigated by using risk management techniques. The risk management techniques were mitigated on software risk factors in Table 15. The study has been conducted on a group of software project managers. Successful software project risk management will greatly improve the probability of project success.

Keywords
Software Risk Management; Software Development Project; Planning Phase; Software Risk Factors; Risk Management Techniques; Fuzzy Regression Analysis Modelling Techniques; Mining Techniques; Statistical Techniques

Introduction
Despite much research and progress in the area of software project management, software development projects still fail to deliver acceptable systems on time and within budget. For some of these reasons corrective action is often difficult to cost-justify or to implement efficiently in practice (Masticola, 2007). Much of the failure could be avoided by managers pro-actively maintenance and dealing with risk factors rather than waiting for problems to occur and then trying to react. Due to the involvement of risk management in monitoring the success of a software project, analyzing potential risks, and making decisions about what to do about potential risks, the risk management is considered the planned control of risk. Integrating formal risk management with project management is a new phenomenon in software engineering and product management community. It requires that project managers need to be involved in a project from the concept phase to the product’s retirement (McNair, 2001). In addition, risk is an uncertainty that can have a negative or positive effect on meeting project objectives. Risk management is the process of identifying, analyzing and controlling risk throughout the life of a project to meet the project objectives (Schwalbe, 2010). However, the goal of risk management at early identification and recognition of risks and then actively changes the course of actions to mitigate and reduce the risk (Miler & Górski, 2002). In the process of understanding the factors that contribute to software project success, risk has become increasingly important. Today, we must think of risk being a part of software project lifecycle and important for a software project survival (Pandian 2007).

In our paper, we identified software risk factors and risk management techniques that guide software project managers to understand and mitigate risks in software development projects. However, Software Development Life Cycle according to (Hoffer, George, & Valacich, 2011), is the process of creating or altering systems, and the models and methodologies that people use to develop these systems. Also it includes these phases as follow (Hoffer et al., 2011): Planning, analysis, design, implementation, and maintenance. In
addition, we focused on planning phase: during this phase, the group that is responsible for creating the system must first determine what the system needs to do for the organization (new requirements gathering) and evaluate existing system/software. According to Taylor, we should apply techniques consistently throughout the software project risk management process (Taylor, 2004). Risk management is a practice of controlling risk and practice consists of processes, methods, and tools for managing risks in a software project before they become problems (Sodhi & Sodhi, 2001).

The objective of this study is: to identify the risk factors of software projects in the Palestinian software development organizations, to rank the software risk factors according to their importance, severity and occurrence frequency based on data source, to identify the activities performed by software project managers to manage the software project risks identified.

**Literature Review**

Wallace and Keil (Wallace & Keil, 2004) explored how different types of risk influence both process and product outcomes in software development projects by analyzing input from more than 500 software project managers representing multiple industries. Elzamly and Hussin (Elzamly and Hussin 2011a) improved quality of software projects of the participating companies while estimating the quality–affecting risks in IT software projects. The results show that there were 40 common risks in software projects of IT companies in Palestine. The amount of technical and non-technical difficulties was very large. The most of the risks were very important. The study has been conducted on a group of managers to improve the probability of project success.

In addition, for the success of software projects, many software projects have very high failure rate. However, we also used new techniques, the regression test and effect size test proposed to managing the risks in a software project and reducing risk with software process improvement. Fourteen risk factors and eighteen control factors were used in this paper. Nine of the fourteen factors were mitigated by using control factors. The study has been conducted on a group of managers (Elzamly & Hussin, 2011). Furthermore, we used the new stepwise regression technique to manage the risks in a software project. Top ten software risk factors in implementation phase and thirty control factors were presented to respondents. These tests were performed using regression analysis to compare the controls to each of the risk factors to determine if they are effective in mitigating the occurrence of each risk factor and selecting best model (Elzamly & Hussin, 2013).

According to (Dash & Dash, 2010) risk management consists of the processes, methodologies and tools that are used to deal with risk factors in the Software Development Life Cycle (SDLC) process of Software Project. Finally, risk management methodology that has five phases: Risk identification (planning, identification, prioritization), risk analysis (risk analysis, risk evaluation), risk treatment, risk controlling, risk communication and documentation and these relied on three categories techniques as risk qualitative analysis, risk quantitative analysis and risk mining analysis. Throughout the life of a software project, the goals should be met.

**Top 10 Software Risk Factors (Planning Phase)**

We displayed the top software risk factors in software development project lifecycle (Planning phase) that are most common used by researchers when studying the risk in software projects. However, the list consists of the 10 most serious risks to a project ranking from one to ten, each risk's status, and the plan for addressing each risk. These factors need to be addressed and thereafter need to be controlled. Consequently, we presented ‘top-ten’ based on survey Boehm’s 10 risk items in1991 on software risk management (Boehm, 1991), the top 10 risk items according to a survey of experienced project managers, Boehm’s 10 risk items 2002 and Boehm’s 10 risk items 2006-2007, (Miler, 2005), the Standish Group survey (CHAOS, 1995), (Addison & Vallabh, 2002), (Addison, 2003), (Khanfar, Elzamly et al., 2008), (Elzamly & Hussin, 2011), (Aloini et al., 2007), (Han & Huang, 2007),( Huang & Han, 2008), (Aritua et al., 2010), (Schmidt et al., 2001), (Keil et al., 1998), ((Nakatsu & Iacovou, 2009), (Chen & Huang, 2009), (Sumner, 2000), (Wallace et al. 2004), (Sumner, 2000), (Boehm & Ross, 1989), (Ewusi-Mensah, 2003), (Paré et al., 2008), (Houston et al., 2001), (Lawrence et al., 2001), (Shafer &Officer, 2004), (Hoodat& Rashidi, 2009), (Christopher Jones et al., 2010), (Capers Jones, 2008), (Taimour, 2005), and another scholars, researchers in software engineering to obtain software risk factors and risk management techniques, these software project risks are:
TABLE 1 ILLUSTRATE TOP TEN SOFTWARE RISK FACTORS IN SOFTWARE PROJECT LIFECYCLE (PLANNING PHASE) BASED ON RESEARCHERS.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>No</th>
<th>Software risk factors</th>
<th>frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>1</td>
<td>Low key user involvement</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Unrealistic schedules and budgets</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>misunderstood / Unrealistic scope and objectives (goals)</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Insufficient/inappropriate staffing</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Lack of senior management commitment and technical leadership</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Poor/inadequate planning and strategic thinking</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Lack of an effective software project management methodology</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Change in organizational management during the software project</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Ineffective communication software project system</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Absence of historical data (templates)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total frequency</td>
<td>101</td>
</tr>
</tbody>
</table>

**Risk Management Techniques**

Through reading the existing literature on software risk management, we listed thirty control factors that are considered important in reducing the software risk factors identified; these controls are:

C1: Using of requirements scrubbing, C2: Stabilizing requirements and specifications as early as possible, C3: Assessing cost and scheduling the impact of each change to requirements and specifications, C4: Develop prototyping and have the requirements reviewed by the client, C5: Developing and adhering a software project plan, C6: Implementing and following a communication plan, C7: Developing contingency plans to cope with staffing problems, C8: Assigning responsibilities to team members and rotate jobs, C9: Have team-building sessions, C10: Reviewing and communicating progress to date and setting objectives for the next phase, C11: Dividing the software project into controllable portions, C12: Reusable source code and interface methods, C13: Reusable test plans and test cases, C14: Reusable database and data mining structures, C15: Reusable user documents early, C16: Implementing/Utilizing automated version control tools, C17: Implement/ utilize benchmarking and tools of technical analysis, C18: Creating and analyzing process by simulation and modeling, C19: Provide scenarios methods and using of the reference checking, C20: Involving management during the entire software project lifecycle, C21: Including formal and periodic risk assessment, C22: Utilizing change control board and exercise quality change control practices, C23: Educating users on the impact of changes during the software project, C24: Ensuring that quality-factor deliverables and task analysis, C25: Avoiding having too many new functions on software projects, C26: Incremental development(deferring changes to later increments), C27: Combining internal evaluations by external reviews, C28: Maintain proper documentation of each individual’s work, C29: Provide training in the new technology and organize domain knowledge training, C30: Participating users during the entire software project lifecycle.

The literature review revealed the following question: Do experienced project managers control software project risk factors by using the controls identified in this paper? To answer this question, the following objectives for the empirical work have been set.

**Empirical Strategy**

Data collection was achieved through the use of a structured questionnaire and historical data for assist in estimating the quality of software through determine risks that were common to the majority of software projects in the analyzed software companies. Top ten software risk factors (planning phase) and thirty risk management techniques were presented to respondents. The method of sample selection referred to as ‘snowball’ and distribution personal regular sampling was used. This procedure is appropriate when members of homogeneous groups (such as software project managers, IT managers) are difficult to locate. The seventy six software project managers have participated in this study. The project managers that participated in this survey are coming from specific mainly software project manager in software development organizations. Respondents were presented with various questions, which used scales1-7. For presentation purposes in this paper and for effectiveness, the point scale as the following: For choices, being headed ‘unimportant’ equal one and ‘extremely important’ equal seven. Similarly, seven frequency categories were scaled into ‘never’ equal one and ‘always’ equal seven. All questions in software risk factors were measured on a seven–point Likert scale from unimportant to extremely important and software control factors were measured on a seven–point Likert scale from never to always.
However, to describe “software Development Company in Palestine” that has in-house development software and supplier of software for local or international market, we depended on Palestinian Information Technology Association (PITA) Members’ webpage at PITA’s website [PITA 2012 www.pita.ps/], Palestinian investment promotion agency [PIPA 2012 http://www.pipa.gov.ps/] to select top IT manager, software project managers. In order to find the relation among risks that the software projects confronts and the counter measures that should be done to reduce risks, many researchers used different statistical methods. In this paper, we used correlation analysis, multiple regression analysis techniques with fuzzy concepts.

**Correlation Analysis**

Clearly, the preceding analysis states that there are correlations between determining variables besides correlation between risk factors and all determining control factors (Rui-ge & Bing-rong, 2011). However, the equation of Correlation Coefficient is the following as (Martín, Pasquier, M., & T., 2005; Marza & Seyyedi, 2009):

\[
 r = \frac{n\left(\sum X_i Y_i\right) - \left(\sum X_i\right)\left(\sum Y_i\right)}{\sqrt{n\left(\sum X_i^2\right) - \left(\sum X_i\right)^2} \sqrt{n\left(\sum Y_i^2\right) - \left(\sum Y_i\right)^2}} 
\]

**Equation 1**

**Regression Analysis Model**

Regression modeling is one of the most widely used statistical modeling technique for fitting a response (dependent) variable as a function of predictor (independent) variables (Martín et al., 2005). Indeed, software risk factor is dependent variable while control factors are independent variables. A linear equation between one and many independent variables (multiple regression) may be expressed as:

\[
 Y = b_0 + b_1 x_1 + b_2 x_2 + \ldots + b_n x_n \]  

**Equation 2**

where b0, b1, b2, ..., and bn are constants; x1, x2, ..., and xn are the independent variables, and y is the dependent variable. The values of b0, b1, b2, ..., and bn of the multiple regression equation may be obtained solving the next linear equations system (Martín et al., 2005).

**Regression Analysis Model with Fuzzy Concepts**

Fuzzy regression analysis is an extension of the classical regression analysis in which some elements of the models are represented by fuzzy numbers (Faktor, Kritikal, & Terjadinya, 2012). On the other words, fuzzy multiple regression model in which response variable is fuzzy variable and part of the covariates are crisp variables (Lin, Zhuang, & Huang, 2012). Therefore, fuzzy regression methods have considerably they are helpful or widened the field of application of classical regression methods in such a way that in determining regression relations from fuzzy initial data, which can be either quantitative and qualitative (Gu, Song, & Xiao, 2006). However, identifies the various data types that may appear in a questionnaire. Then, we introduce the questionnaire data mining problem and define the rule patterns that can be mined from questionnaire data. A unified approach is developed based on fuzzy techniques so that all different data types can be handled in a uniform manner (Chen & Weng, 2009). Therefore, in order to discover rules from a questionnaire dataset, we need a brand new approach that can deal with different data types occurring (Chen & Weng, 2009). Therefore the same authors explained all data types could be represented and operated from fuzzy oints of view. Furthermore, we must extend the crisp association rules to fuzzy association rules from questionnaire data.

**Fuzzy Concepts with Membership Function**

Fuzzy concepts help us to find the deviation of each data from fitness equation, so we define a normal distribution membership function as follow (Marza & Seyyedi, 2009):

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

**Equation 2**

Where μ is average of sample points and σ is square root of variance math. If we add fuzzy domain to regression method, the effect of discrete data points on the fitness result will be reduced and the effect of concentrated data points on the fitness result will be enhanced. Indeed, a membership function is a curve that defines how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1 (Faktor et al., 2012).

**Fuzzy Parameters**

A group of equations to obtain the fuzzy parameters are provided as (Gu et al., 2006; Popescu & Giuclea, 2007):

\[
\begin{align*}
 &s_{11} b_1 + s_{12} b_2 + \ldots + s_{1k} b_k = s_{1y} \\
 &s_{21} b_1 + s_{22} b_2 + \ldots + s_{2k} b_k = s_{2y} \\
 &s_{31} b_1 + s_{32} b_2 + \ldots + s_{3k} b_k = s_{3y} \\
 &s_{41} b_1 + s_{42} b_2 + \ldots + s_{4k} b_k = s_{4y} \\
 &s_{51} b_1 + s_{52} b_2 + \ldots + s_{5k} b_k = s_{5y}
\end{align*}
\]
Here, $s_{ij} = \sum u_i u_j x_{ij} - \sum u_i x_j y_i$, and $s_{iv} = \sum u_i v_j x_{iv} - \sum u_i x_i y_i$.

According to this group of equations, first we can obtain the values of variables $b_1, b_2, \ldots, b_k$, and finally $b_0$ is gained by:

$$b_0 = \frac{\sum u y - b_1 \sum u x_1 - b_2 \sum u x_2 - \cdots - b_k \sum u x_k}{\sum u}$$

Equation 4

**Coefficient of Determination**

Coefficient of determination is used to assess the quality of estimation models and expressed by $R^2$. The coefficient $R^2$ calculated by (Gu et al., 2006):

$$R^2 = \frac{\sum u (y - \bar{y})^2}{\sum u (y - \bar{y})^2}$$

Equation 5

Here, $\bar{y}$ expresses the mean value of random variables. Obviously, the coefficient $R^2$ describes the percentage of variability and the value is between 0 and 1; when an $R^2$ is close to 1, it indicates that this model can explain variability in response to the predictive variables, so called there is a strong relationship between the independent and dependent variables.

**Importance of Risk Factors in Analysis Phase**

All respondents indicated that the risk of “Ineffective communication software project system” and “absence of historical data (templates)” were the highest risk factors. In fact, the all risk factors in planning phase were important; and aggregating the responses resulted in the following ranking of the importance of the listed risks (in order of importance): Risk9, Risk 10, Risk3, Risk1, Risk 6, Risk 8, Risk 7, Risk2, Risk 4, and Risk 5.

**Frequency of Occurrence of Controls**

Table 4 shows the mean and the standard deviation for each control factor. The results of this paper show that most of the controls are used most of the time and often.

**Ranking of Importance of Risk Factors for Project Managers’ Experience**

As the results in Table 3 show that most of the risks are important the overall ranking of importance of each risk factor for the three categories of project managers’ experience.
Relationships Between Risks and Risk Management Techniques

Regression technique was performed on the data to determine whether there were significant relationships between risk management techniques and risk factors. These tests were performed using fuzzy multiple regression analysis, to compare the controls to each of the risk factors to determine if they are effective in mitigating the occurrence of each risk factor. Relationships between risks and controls which were significant and insignificant, any control is no significant, which is not reported according to the best model with fuzzy concepts.

R1: RISK OF ‘LOW KEY USER INVOLVEMENT’ COMPARED TO CONTROLS.

Equation 6

\[
\text{Fuzzy Risk}_1 = 3.341376335 + 0.142586809*C6 + 0.154868976*C21
\]

R2: RISK OF ‘UNREALISTIC SCHEDULES AND BUDGETS’ COMPARED TO CONTROLS.

Equation 7

\[
\text{Fuzzy Risk}_2 = 3.86937566 + 0.183643096*C1
\]

R3: RISK OF ‘MISUNDERSTOOD / UNREALISTIC SCOPE AND OBJECTIVES (GOALS)’ COMPARED TO CONTROLS.

Equation 8

\[
\text{Fuzzy Risk}_3 = 3.9149441233 + 0.181885943*C1
\]

R4: RISK OF ‘INSUFFICIENT/INAPPROPRIATE STAFFING’ COMPARED TO CONTROLS.

Equation 9

\[
\text{Fuzzy Risk}_4 = 3.724585896 + 0.163857928*C6 + 0.173857928*C7
\]
regression analysis to make fuzzy multiple regression model by solving these equations, the final fuzzy equation is:

\[
\text{Fuzzy Risk}_4 = 3.46981570353 + 0.239410208*\text{C6}
\]  

Equation 9

R5: Risk of ‘Lack of Senior Management Commitment and Technical Leadership’ Compared to Controls.

<table>
<thead>
<tr>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
<th>C8</th>
<th>C9</th>
<th>C10</th>
</tr>
</thead>
<tbody>
<tr>
<td>.370**</td>
<td>.272*</td>
<td>.309**</td>
<td>.233*</td>
<td>.390**</td>
<td>.293*</td>
<td>.293*</td>
<td>.308**</td>
<td>.307**</td>
<td>.293*</td>
</tr>
</tbody>
</table>

Tables show that the significant value is less than the assumed value at the \( \alpha = 0.05 \) level of significance, so there is a positive relation among controls 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 16, 18, 19, 20, 21, 22, 24, 25, 28, and risk 5. Controls 6 and 16 have an impact on the risk 5. In addition, the results show that controls 6, 16 have a positive impact value of 0.433, 0.329 respectively, multiple correlation is 0.498 and value of \( R^2 \) is 0.0829. This interprets as a percentage of 8.29% from the dependent variable of risk 5. According to the fuzzy concepts in multiple regression analysis to produce fuzzy multiple regression model by solving these equations, the final fuzzy equation is:

\[
\text{Fuzzy Risk}_5 = 2.539737951 + 0.216982595*\text{C6} + 0.194493584*\text{C16}
\]  

Equation 10

R6: Risk of ‘Poor/Inadequate Software Project Planning and Strategic Thinking’ Compared to Controls.

<table>
<thead>
<tr>
<th>C24</th>
<th>C25</th>
</tr>
</thead>
<tbody>
<tr>
<td>.294*</td>
<td>.243*</td>
</tr>
</tbody>
</table>

Tables show that the significant value is less than the assumed value at the \( \alpha = 0.05 \) level of significance, so there is a positive relation among controls 3, 4, 5, 6, 14 and risk 6. Also controls 5, 14, 27 have an impact on the risk 6. In addition, the results show that controls 3, 25 have a positive impact value of 0.268 and 0.254 respectively, multiple correlation is 0.498 and value of \( R^2 \) is 0.0829. This interprets as a percentage of 8.29% from the dependent variable of risk 5. According to the fuzzy concepts in multiple regression analysis to produce fuzzy multiple regression model by solving these equations, the final fuzzy equation is:

\[
\text{Fuzzy Risk}_6 = 3.822153303 + 0.127478083*\text{C5} + 0.146586095*\text{C14} - 0.073867473*\text{C27}
\]  

Equation 11

R7: Risk of ‘Lack of An Effective Software Project Management Methodology’ Compared to Controls.

<table>
<thead>
<tr>
<th>r</th>
<th>C24</th>
<th>C25</th>
</tr>
</thead>
<tbody>
<tr>
<td>R7</td>
<td>.394**</td>
<td>.294*</td>
</tr>
</tbody>
</table>

Tables show that the significant value is less than the assumed value at the \( \alpha = 0.05 \) level of significance, so there is a positive relation among control 24, 25 and risk 7. The control 24 has an impact on the risk 7. In addition, the results show that the control 24 has a positive impact value of 0.394 and the value of \( R^2 \) is 0.0717. This interprets as a percentage of 7.17% from the dependent variable of risk 7. According to the fuzzy concepts in multiple regression analysis to produce fuzzy multiple regression model by solving these equations, the final fuzzy equation is:

\[
\text{Fuzzy Risk}_7 = 3.076111211 + 0.317332769*\text{C24}
\]  

Equation 12

R8: Risk of ‘Change in Organizational Management During The Software Project’ Compared to Controls.

<table>
<thead>
<tr>
<th>r</th>
<th>C17</th>
</tr>
</thead>
<tbody>
<tr>
<td>R8</td>
<td>.255*</td>
</tr>
</tbody>
</table>

Tables show that the significant value is less than the assumed value at the \( \alpha = 0.05 \) level of significance, so there is a positive relation between control 17 and risk 8. Also controls 6, 17, 25, and 27 have an impact on the risk 8, multiple correlation value is 0.496, and the value of \( R^2 \) is 0.131. This interprets as a percentage of 13.12% from the dependent variable of risk 8. According to the fuzzy concepts in multiple regression analysis to produce fuzzy multiple regression model by solving these equations, the final fuzzy equation is:

\[
\text{Fuzzy Risk}_8 = -0.752758243 - 0.0718*\text{C6} + 0.556*\text{C17} + 0.4728*\text{C25} + 0.00039532*\text{C27}
\]  

Equation 13

R9: Risk of ‘Ineffective Communication Software Project System’ Compared to Controls.

<table>
<thead>
<tr>
<th>r</th>
<th>C24</th>
<th>C26</th>
</tr>
</thead>
<tbody>
<tr>
<td>R9</td>
<td>.272*</td>
<td>.233*</td>
</tr>
</tbody>
</table>

Tables show that the significant value is less than the assumed value at the \( \alpha = 0.05 \) level of significance, so there is a positive relation among control 24, 26 and risk 9. Also controls 5, 24, 25, and 27 have an impact
on the risk 9. In addition, the results show that the control 24, 26 have a positive impact value of 0.272, and 0.233 respectively, also multiple correlation value is 0.500, and the value of $R^2$ is 0.3304. This interprets as a percentage of 33.04% from the dependent variable of risk 9. According to the fuzzy concepts in multiple regression analysis to produce fuzzy multiple regression model by solving these equations, the final fuzzy equation is:

$$\text{Fuzzy Risk9} = 0.249758118 + 0.2721*C5 + 0.3131*C24 + 0.3293*C25 + 0.0003*C27$$

Equation 14

R10: Risk of ‘Absence of a Historical Data (Templates)’ Compared to Controls.

TABLE 14 ILLUSTRATE THE VALUE OF CORRELATION

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk 9</td>
<td>.312**</td>
<td>.354**</td>
<td>.379**</td>
<td>.349**</td>
<td>.331**</td>
<td></td>
</tr>
<tr>
<td>Risk 10</td>
<td>.370**</td>
<td>.253*</td>
<td>.234*</td>
<td>.256*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tables show that the significant value is less than the assumed value at the $\alpha = 0.05$ level of significance, so there is a positive relation among controls 1, 3, 4, 5, 6, 7, 8, 10, 29 and risk 10. Also the control 4 has an impact on the risk 10. In addition, the results show that the control 4 has a positive impact value of 0.379, and the value of $R^2$ is 0.05815. This interprets as a percentage of 5.815% from the dependent variable of risk 10. According to the fuzzy concepts in multiple regression analysis to produce fuzzy multiple regression model by solving equations, the final fuzzy equation is:

$$\text{Fuzzy Risk10} = 4.393717936 + 0.098137359*C4$$

Equation 15

Software Risk factors identification checklists and control factors (risk management techniques)

Table 15 show risk factors identification checklist with risk software projects based on a questionnaire of experienced software project managers. We can use the checklist on software projects to identify and mitigate risk factors on lifecycle software projects (planning phase) by risk management techniques.

**Conclusions**

The concern of our paper is the managing risks of software projects. The results show that all risks in software projects(planning phase) are important in software project manager perspective, whereas all controls are used most of time, and often. Therefore, the software risk factors in planning phase from risk number Risk 9, Risk 10, Risk3, Risk 1, Risk 6, Risk 8, Risk 7, Risk 2, Risk 4, and Risk 5 were identified as important. The results of this paper showed also that most of the top ten controls are used most of the time. However, “provide training in the new technology and organize domain knowledge training” is the highest; and aggregating the responses resulted in the following ranking of the importance of the listed controls (in order of importance): C29, C30, C20, C27, C21, C19, C28, C25, C26, and C23. These tests were performed using fuzzy multiple regression analysis with fuzzy concepts, to compare the controls to each of the software risk factors to determine if they are effective in mitigating the occurrence of each risk factor. Relationships between risks and controls which were significant and insignificant, and any control is not significant, which is not reported. However, we determined the positive correlation between risk

**TABLE 15 SOFTWARE RISK FACTORS(PLANNING PHASE) WERE MITIGATED BY RISK MANAGEMENT TECHNIQUES**

<table>
<thead>
<tr>
<th>No</th>
<th>Software Risk Factors(planning phase)</th>
<th>Risk Management Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low key user involvement.</td>
<td>C6: Implementing and following a communication plan, C21: Including formal and periodic risk assessment.</td>
</tr>
<tr>
<td>2</td>
<td>Unrealistic schedules and budgets.</td>
<td>C1: Using of requirements scrubbing.</td>
</tr>
<tr>
<td>3</td>
<td>Misunderstood / Unrealistic scope and objectives (goals).</td>
<td>C6: Implementing and following a communication plan.</td>
</tr>
<tr>
<td>4</td>
<td>Insufficient/inappropriate staffing.</td>
<td>C6: Implementing and following a communication plan.</td>
</tr>
<tr>
<td>5</td>
<td>Lack of senior management commitment and technical leadership.</td>
<td>C6:Implementing and following a communication plan, C16:Implementing/Utilizing automated version control tools</td>
</tr>
<tr>
<td>6</td>
<td>Poor/inadequate software project planning and strategic thinking.</td>
<td>C5: Developing and adhering a software project plan, C14: Reusable database and data mining structures, 27: Combining internal evaluations by external reviews.</td>
</tr>
<tr>
<td>7</td>
<td>Lack of an effective software project management methodology.</td>
<td>C24: Ensuring that quality-factor deliverables and task analysis.</td>
</tr>
<tr>
<td>8</td>
<td>Change in organizational management during the software project.</td>
<td>C17: Implement/ utilize benchmarking and tools of technical analysis, C27: Combining internal evaluations by external reviews, C25: Avoiding having too many new functions on software projects, C6: Implementing and following a communication plan.</td>
</tr>
<tr>
<td>9</td>
<td>Ineffective communication software project system.</td>
<td>C24:Ensuring that quality-factor deliverables and task analysis, C27: Combining internal evaluations by external reviews, C25:Avoiding having too many new functions on software projects, C5:Developing and adhering a software project plan</td>
</tr>
<tr>
<td>10</td>
<td>Absence of a historical data (templates).</td>
<td>C4: Develop prototyping and have the requirements reviewed by the client.</td>
</tr>
</tbody>
</table>
factors and risk management techniques, then measured impact risk in software project lifecycle. We used correlation analysis, fuzzy multiple regression analysis techniques proposed. However, the risk management techniques were mitigated on software risk factors in Table 15. Through the results, it was found out that some control haven’t impact, so the important controls should be considered by the software development companies in Palestinian. In addition, we cannot obtain historical data form database until some techniques are used. As for future work, we will intend to apply these study results on a real-world software project to verify the effectiveness of the new techniques and approach on software project. We can use more techniques useful to manage software project risks such as neural network, genetic algorithm, Bayesian statistics, and so on.

REFERENCES


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