The Importance of Decision Strategy and Role in a Software Change Impact Analysis Performance

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Abstract: Software change impact analysis is defined as a process of identifying the potential impact of disruption caused by a change to one or more components in the data center on other components. Change impact analysis is defined as identifying the potential consequences of a change or estimating what needs to be modified to accomplish a change. The term "impact analysis" is used with many meanings, its used for characterizing and comparing diverse change impact analysis approaches, it corresponds to how an approach is used to accomplish change impact analysis and how an approach does change impact analysis internally and the effectiveness of the impact analysis approach. As the project management community recognizes the growing need to identify the consequences of changes. Some recent surveys reported that the project failure rate has increased over the last two decades. Because, the software projects capacities increase with the lack of appropriate approach of software change requirement management. However, this paper deals with investigating further change impact analysis issues at IT companies in Malaysia, by looking their Organizational decision level and how they applied it and profile them. Subsequently, it proposes the appropriate team for software change impact analysis performance.

Key words: Software Change Impact Analysis approaches - Change requirement - Project management practitioners - Change control - Change decision and Role of change impact analysis

INTRODUCTION

Performing impact analysis is an important step when changing or maintaining software, especially in incremental processes [1]. It allows to judge the amount of work required to implement a change [2], proposes software artifacts which should be changed [3] and helps to identify test cases which should be re-executed to ensure that the change was implemented correctly [4]. Software change impact analysis also enables developers and project leaders to ask “what if...?” Questions and to simulate alternative scenarios without having to implement them. However, maintenance is considered to be the most expensive [5] and long-lasting phase in the Lifecycle of most software systems, where more than 50% of all maintenance costs arise from changing software [6]. Every development or analysis step which can be automated can save a lot of time and cost. Partial implemented changes may cause high risks. They are likely to cause unintended side effects, introduce new bugs and lead to more instability, rather than improving the software. Today’s evolutionary development and frequent changes demand for changing software and change has become a daily routine for architects, programmers and project leaders. However, the main objective is to investigate the influenced factors that can support current software change impact analysis in software project development enterprises in Malaysia.

Related Works: Aurum and Wohlin tie requirements engineering (RE) activities to decision-making models, arguing that RE is a Decision intensive process [8]. They suggest that studying decision making within RE helps organizations structure their RE decisions better and, ultimately, produce software with higher quality. This paper proposes that the same argument holds for SCIA due to the strong connection between SCIA and RE. In some cases, impact analysis has been performed for a

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very long time, albeit not necessarily using that term and not necessarily resolving the problem of accurately determining the effect of a proposed change. The need for software practitioners to determine what to change in order to implement requirement changes has always been present. Strategies for performing impact analysis were introduced and discussed early in the literature. Besides that, Numerous researchers highlighted on differences between project board and managers in the context of project management concept, for example, concerning about the views of software project quality [7], use of formal routines to transfer information and experience [9] and how they rate factors affecting project goal [4]. Although project managers mostly have more information and knowledge than project board, based on that, manager’s priority for this specific work are more likely to align well with those of the organization. So that, differences between managers and engineers could be attributed to differences between the organizational alignments of their default perspectives [1].

Haney’s study [17] on a technique for module connection analysis is often referred to as the first paper on impact analysis [17]. The technique builds on the idea that every module pair of a system has a probability that a change in one module in the pair necessitates a change in the other module. The technique can be used to model change propagation between any system components including requirements. In 1996, Bohner and Arnold [15] published a collection of research articles entitled Software Change impact analysis [16]. The objective of the collection was to present the current, somewhat scattered, material that was available on impact analysis at the time. When reading the collection today, nearly ten years later, it becomes apparent that it still very relevant [10]. Papers published after 1996 seem to work with the same ideas and techniques. It does not mean to depreciate the work that has been done, but it indicates that the field is not in a state of flux. Rather, the focus remains on adapting existing techniques and strategies to new concepts and in new contexts. Software change impact analysis on the architectural level is an example of this [9].

**Challenges of Change Impact Analysis:** Challenges are what make life interesting; overcoming them is what makes life meaningful” [18]. Impact analysis has been practiced in various forms for years, yet there is no consensus definition. For example, IA does not appear in the IEEE Glossary of project development terminology. The most critical issues in project requirement change are change decision and the effectiveness of change impact analysis classification. The problems in conducting an Impact Analysis are firstly to capture and structure all the likely consequences of a decision; and then, importantly, to ensure that these are managed appropriately [19]. For smaller decisions, it can be conducted as a desk exercise.

Furthermore, it is hard to decide what is meant by Impact Analysis. People rarely give explicit definition. An interview conducted with some project management practitioner experts agree that when change request happen into the ongoing project, the most challenged part is project developer’s team, because developers dislike to change while project manager like to keep customer satisfaction and there is a lack of dimensions for comparing one impact analysis approach with another [20]. Hence, it is hard to know if there is no enough information available for significant comparison. Further, it’s also hard to discover when different work on Impact Analysis is related and difficulty to discover what work contributes to impact analysis and what does not. However, analyzing the relationships to identify consequences of a change can be difficult as well.

**MATERIALS AND METHODS**

Methodology is procedure used to ensure that research activities are well organized in terms of activities as well as the achieving goals. By implementation of some methodologies, documents and data can be achieved as result of activities and tasks that are included in the methodology. In order to get practitioners perception and ideas about software change impact analysis (SCIA), we adopted survey method to collect the primary data of study. The survey method was suitable because, usually it used to explore subjects’ ideas and perceptions and it can empirically test the generalizability of the research outcome. We developed the survey instrument followed by general instrument development guidelines [31, 32]. Although most of the research items are derived from past studies and modified to support software change management but it have not been applied in SCIA process improvement context.

A survey questionnaire where distributed with IT entrepreneurs experts. A sample of population of software development practitioners has been considered to collecting data. The main target group was project board, project manager and deliverables (developers). The majority of the people surveyed were project team, the second majority was project manager and project board was the smallest number. In addition to that, a total of 453 questionnaires were distributed with 25different
project management companies in Malaysia, 209 completed and usable questionnaires were returned. These companies were randomly selected from 37 firms list Published by Malaysian Small, Medium and large Enterprises Info web page, the survey were distributed face to face, two weeks’ time frame were given to finish and complete the survey. Besides that, the items used to operationalize, as mentioned earlier were mainly adapted from previous studies and modified for use in the change impact analysis process context. Subsequently, all elements of the survey were measured using a five-point Likert-type scale (ranging from 1 Unimportant to 5 critical).

Additionally, 58.4% of the respondents totally disagreed that they do SCIA approach for their project. Doing so requires having proper approach of change impact identification and analyzing them in order to be taken the right decisions. The majority of the respondents agree that change impact identification is very significant activity in their project, they also agreed on not using any standard process of change impact analysis. However, its important to know, how do they identify change impacts and why they do not use standard process of change impact analysis for their projects? Based on that, most of change impact identification for software development companies handled them manually and they don’t have any guideline or effective process that can support them to have accurate decision for their long term project goals. More specifically, practitioners approved that current impact analysis process is not supporting to the current software change management process.

Data Analysis
Decision Issues with Prioritization: Data analysis was conducted separately from other primary data analysis for two purposes. The first purpose was to determine the participants’ perspective on organizational levels. Its possible to deduce their strategic level. Most of the respondents play strategic level in the process which intended to consider as belonging to the organizational level. This process was used as Aurum and Wohlin [24] point out, Anthony’s decision levels are not entirely orthogonal. The second purpose was to identify issues of software change management based on respondents’ feedback. The data analysis used prioritization method; the issue with the highest value was the one of the most critical to the organization if it existed, thereby looking at the issues under the organizational perspective. As we will explain in the following section, decision issues in software change management increasing with the increment of software complexity. We have divided decisions into three different levels, Strategic, Tactical and Operative [24]. Each and every decision has its own strategies and processes. However, having decision strategies for the software change management in the beginning of the project is one of the most important activities for every software project development [24].

During this paper, different parts of decision activities were identified. As mentioned above, Anthony [24] proposes three types of decision making activities in the projects, based on the objectives of management activities: strategic planning, management operational control. The boundaries between these types are not distinct. Based on the required information, each one differs from the other. According to Anthony [25] model, it focuses more on strategic planning decisions which are allied to the project goals. The information related to these decisions, mostly are incomplete and the decision-making process may extend over a considerable period of time.

Change Rate Decisions: According to Saffena Ramzan and Naveed Jkram study on 2005 [31] shows that change decision is an activity that should be done throughout the Lifecycle of the project development. But the point of stress is that how these decisions should be done? So, having a proper decision, solid foundation of information should be needed. The information that received to have a decision must be clear, accessible on time and appropriate for the target decision [32]. The information from the assessment of change development should be accurate and suitable for proper decision. Besides that, there are several ways to rate the severity of the change impact such as: Minor, Significant, Major and critical. Each and every type has its own risks, procedures and activities [32].

Several ways have been identified to rate the severity of change impacts, when deciding what severity of change can be dealt with the level of management as the project board may consider delegating some decision making for accepting/rejecting requests for change or off-specifications to a change authority and whether to provide a budget to pay for the changes. Usually, software change management involves Change Control Board, project manager and developers [32]. Project board has overall control at a project level, as long as forecasts tolerances for each management to the project manager. The project board has the ability to review progress and decide whether to continue the change or reject. Some other studies know change control as Strategic decision makers or organizational level [33]. Project manager has day to day control for a managing stages within the
tolerance limits laid down by the project board, It also known in some other studies tactical. The final role of project management is team manager; he has control for a work package, but only within the work package tolerances agreed with the project manager. This role is also known as operational or development. the development consists of several roles of software development stakeholders such as; Designer, Tester Programmer, Manager Change Control Board and Architect.

However, in order to play his/her role for each and every one of the software change management members, it’s important to have pre-defined decision strategy for the software change control. The project manager and project board might agree that minor change can be dealt by team manager (operation) and significant change can be decided by project manager (tactical) and finally, major or critical changes will be decided by project board. Hence, having such role description will support project developers to have right decision at right time with less cost and effort.

Role: As defined by Joenson [34] role is “the individual responsibility of the stakeholders during the software development [34]. Identifying the role of the person influence the development of the change as well as the decision of the outcome. As the project development team consists of different stakeholders, its important to describe who is appropriate team for handling software change impact analysis. Its one of the reasons of why most of existing processes are not supporting current software change impact analysis. Additionally, Measuring the significance of individual role of Change Impact analysis is important than applying with defined process. Jonsson [34] defines that role can be measured into: Designer, Programmer, Tester, Manager and Change Control Board. It has and influence with change development as well as decision strategy. Because, appointing the right people to the right position at right time will lead the work to the right path which is high quality product, on time with less cost.

The question about what extent that the activity in the role and responsibility is important in the sense that the respondents made use of all five response options, As response option three which is important and option 4 which is strongly agree account for 50% or more of the answers from all roles, the agreement among roles can be seen as large [35]. So the designers have a somewhat more positive view than other roles, whereas testers and programmers stand out because designers are more close to the documentation, knowledgeable about the project requirement lifecycle and they are the one who developed connectivity of the project, requirement analysis and the sequences of the requirements as well as their relationships. Software change impact analysis, significantly more important to improve for designers than for other roles [34]. The reason may be that designers use the documentation more than other roles when determining change impact.

In this paper we have identified that designers are the most appropriate team of SCIA performance, as shown the analyzed data in table 1. First item frequently specified by all roles except the team managers besides that, more than 66.7 % of the respondents agreed that designers are the most appropriate group for change impact analysis performance. Second, Product manager were the second highest item which yields 50% of the respondents’ feedback. Third, software change impact analysis was considerably more frequent for designers than for any other role. However, it should be noted that most appropriate group for impact analysis performance is designers. Based on the frequencies shown in Table 1; consequently, they create system descriptions that the programmer can be base the implementation and requirement mansagements. Therefore, they can be conducted the process with short time and less cost; hence, to trace the requirement and identify the impact of the change will be simply conducted. The following Table 1 shows clearly above discussion.

**How Impact Analysis Applied?** Change impact analysis used to apply generally when change happened in software currently under development or requests for enhancements in current projects or reports of problems in current production or beta test systems [18]. the evaluator uses impact analysis approach to identify the factors that causes the change, identify those requirements which are highly affected by the change (this information is acquired by previous history of requirements or intuition), identifies the consequences of the changes, performs change analysis on other requirements by looking, design, cost, schedule, safety, performance, reliability, maintainability, adoptability, size and human factors [13]. After identifying all above factors the evaluator decide whether the requested change can be included into the ongoing project or not with respect to the predefined change strategy [14].

On the other hand, change impact analysis approach used when the change evaluator of the project need to identify the ripple effect of change request and estimate
Table 1: Role of change impact analysis

The extent to which the respondents agree or disagree was based on these scales, 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree and 5: Strongly Agree.

<table>
<thead>
<tr>
<th>No.</th>
<th>Role</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Architect</td>
<td>3.1</td>
<td>9.1</td>
<td>27.3</td>
<td>25.0</td>
<td>35.5</td>
</tr>
<tr>
<td>2</td>
<td>Designer</td>
<td>4.2</td>
<td>0.0</td>
<td>66.7</td>
<td>27.3</td>
<td>1.9</td>
</tr>
<tr>
<td>3</td>
<td>Process group member</td>
<td>2.3</td>
<td>0.0</td>
<td>33.3</td>
<td>33.0</td>
<td>31.4</td>
</tr>
<tr>
<td>4</td>
<td>Functional manager</td>
<td>5.5</td>
<td>2.0</td>
<td>20.0</td>
<td>12.3</td>
<td>60.2</td>
</tr>
<tr>
<td>5</td>
<td>Project manager</td>
<td>3.3</td>
<td>12.5</td>
<td>14.5</td>
<td>21.3</td>
<td>48.4</td>
</tr>
<tr>
<td>6</td>
<td>Programmer</td>
<td>6.0</td>
<td>7.0</td>
<td>44.0</td>
<td>37.5</td>
<td>6.0</td>
</tr>
<tr>
<td>7</td>
<td>Tester</td>
<td>7.7</td>
<td>15.4</td>
<td>33.0</td>
<td>25.0</td>
<td>18.9</td>
</tr>
<tr>
<td>8</td>
<td>Product manager</td>
<td>25.0</td>
<td>0.0</td>
<td>50.0</td>
<td>22.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Table 2: Current Practice of Change Impact Analysis Issues

The extent to which the respondents agree or disagree was based on these scales, 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree and 5: Strongly Agree.

<table>
<thead>
<tr>
<th>No.</th>
<th>Issues</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Currently, Impact analysis checklist process is not perfectly supported current software projects</td>
<td>4.8%</td>
<td>12.0%</td>
<td>49.8%</td>
<td>29.2%</td>
<td>4.3%</td>
</tr>
<tr>
<td>2</td>
<td>Most of the Solutions are specified with too many details by high-level analysts to perform accurate decision.</td>
<td>2.9%</td>
<td>12.4%</td>
<td>43.1%</td>
<td>35.9%</td>
<td>5.7%</td>
</tr>
<tr>
<td>3</td>
<td>The existing Models are difficulty to classify the change using change impact analysis</td>
<td>3.3%</td>
<td>12.4%</td>
<td>49.3%</td>
<td>32.2%</td>
<td>2.2%</td>
</tr>
<tr>
<td>4</td>
<td>Mostly, Analysis are performed by the wrong persons</td>
<td>4.8%</td>
<td>20.6%</td>
<td>38.3%</td>
<td>32.1%</td>
<td>4.3%</td>
</tr>
<tr>
<td>5</td>
<td>In the tools, there is no option for determining the type of change.</td>
<td>3.8%</td>
<td>19.1%</td>
<td>44.0%</td>
<td>27.8%</td>
<td>4.8%</td>
</tr>
<tr>
<td>6</td>
<td>The existing Tools are not supporting to document impact, cost and decisions</td>
<td>2.9%</td>
<td>15.3%</td>
<td>45.5%</td>
<td>29.7%</td>
<td>6.7%</td>
</tr>
<tr>
<td>7</td>
<td>Different change request have different levels of complexity, and there is no strategy for appropriate decision.</td>
<td>2.9%</td>
<td>12.4%</td>
<td>42.6%</td>
<td>35.4%</td>
<td>6.2%</td>
</tr>
<tr>
<td>8</td>
<td>In the current tools and frameworks, the relevant structure and change specification to support the analysis are missing</td>
<td>1.0%</td>
<td>16.7%</td>
<td>44.5%</td>
<td>34.0%</td>
<td>3.3%</td>
</tr>
<tr>
<td>9</td>
<td>Responsibilities and project balance are difficult to handle for analyses that span several systems.</td>
<td>1.4%</td>
<td>11.5%</td>
<td>41.6%</td>
<td>38.3%</td>
<td>7.2%</td>
</tr>
<tr>
<td>10</td>
<td>Tools are not integrated the outcome of changes impact analysis with decision process</td>
<td>2.9%</td>
<td>12.0%</td>
<td>41.1%</td>
<td>35.9%</td>
<td>7.7%</td>
</tr>
<tr>
<td>11</td>
<td>Mostly, stakeholders are dislike to perform impact analysis</td>
<td>2.9%</td>
<td>11.0%</td>
<td>38.8%</td>
<td>36.8%</td>
<td>9.1%</td>
</tr>
<tr>
<td>12</td>
<td>There is no standard Impact Analysis process strategy for the complexity of software projects</td>
<td>2.4%</td>
<td>7.2%</td>
<td>39.2%</td>
<td>39.7%</td>
<td>11.0%</td>
</tr>
<tr>
<td>13</td>
<td>Current practices, Analyses and change implementation evoke stress.</td>
<td>1.4%</td>
<td>9.6%</td>
<td>42.1%</td>
<td>36.4%</td>
<td>10.5%</td>
</tr>
<tr>
<td>14</td>
<td>Current tools, Analysis require much expertise and experience</td>
<td>1.4%</td>
<td>9.1%</td>
<td>38.3%</td>
<td>41.6%</td>
<td>9.6%</td>
</tr>
<tr>
<td>15</td>
<td>Using the frameworks, there is not enough time to carry out impact analysis.</td>
<td>1.9%</td>
<td>11.5%</td>
<td>42.1%</td>
<td>36.8%</td>
<td>7.7%</td>
</tr>
<tr>
<td>16</td>
<td>Tools are very challenge to get resources for conducting impact analysis</td>
<td>2.1%</td>
<td>10.5%</td>
<td>42.6%</td>
<td>37.8%</td>
<td>5.7%</td>
</tr>
<tr>
<td>17</td>
<td>Using the oracle database in, the requirements databases have relatively limited records and decision making.</td>
<td>4.3%</td>
<td>11.0%</td>
<td>48.3%</td>
<td>32.1%</td>
<td>4.3%</td>
</tr>
<tr>
<td>18</td>
<td>In the current practices, Change request decisions are based on interest</td>
<td>3.8%</td>
<td>12.0%</td>
<td>41.1%</td>
<td>36.4%</td>
<td>6.7%</td>
</tr>
</tbody>
</table>

In this paper, we have presented analysis and discussion from a study where impact analysis issues were prioritized by using statistical analysis tool (SPSS) at three different organizational levels (operative, tactical and strategic). The organizational perspective was used to learn about which issues were critical for the organization. The overarching goal was to explore the role of impact analysis in the project development, in order to be able to improve ways of working with impact analysis. In this paper we are dealing with the confirmation of existing issues based on primary data to address the appropriate approach of current process improvement. Further, quantitative analysis was conducted during the analysis of the collected data. The researcher used to
analyze the data using quantitative method. When the data collected in quantitative manner, the intent was to first explore the problem under study and then follow up on this exploration with quantitative method that are amenable to studying a large sample so that results might inferred to a population. Normally, when quantitative data proceed, the intent is to explore with a large sample first to test variables and then explore more in depth with a few cases during the quantitative phase. In concurrently gathering both forms of data at the same time, the researcher seeks to compare both forms of data to search for congruent finding.

Thus, this section provides an opportunity to present further investigation of quantitative data that goes beyond the research questions in this study. It also discuss the analysis of the collected data presented above, a quantitative (Statistical) analysis have been performed for the original data collected from the main respondents. The purpose of the statistical analysis was to investigate how the perception of the participants expressed as numerical Prioritization values differ according to the prioritization perspective. The prioritization step was one of the most important targets during the data analysis. The issues were Prioritized using SPSS tool. Originally, when we identified the issues from the literature, we identified three different levels in organization, based on that we developed an interview instrument to get practitioners’ perception in order to know whether these issue practically exist in the platform and prioritize it to identify which issue carries more load. Therefore, the analyzed data shows that, these issues are the most important which carries more loading. In other words, these issues are the most critical and hottest in a current process of change impact analysis as shown in the below table.

**CONCLUSION**

During this paper, we have highlighted the following points: (1) Studying issues from multiple perspectives and levels is rewarding and entails certain benefits from a process improvement point of view. (2) The most important issues concern fundamental aspects of impact analysis and its execution. (3) It should be noted that most appropriate group for impact analysis performance is designers, because, they can be conducted the process with short time and les cost; hence, to trace the requirement and identify the impact of the change will be simply conducted. Impact analysis is significantly more important to improve for designers than for other roles. The reason may be that designers use the documentation more than other roles when determining change impact. (4) we also identified how change impact analysis should applied and when. This underlines that impact analysis needs to be addressed as a crucial activity in the change management process. More specifically, it is imperative to realize that processes need to not only enforce the existence of proper impact analysis, but also to prescribe how impact analysis should be carried out in order to achieve satisfactory and timely results.

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