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VALIDATING DECISION MAKING SOFTWARE PROCESS MODEL

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ABSTRACT An imperative step in designing a framework which should assist project managers in the decision making consists of the validation of the framework. Validation aims at finding whether or not the framework does what it is intended to do. However, absolute validation is a myth. To be as sure as possible that the framework is valid, years of testing and experimenting is inevitable. This is not feasible for this research. Therefore, in this only three validation techniques are applied. The result of these tests will not indicate whether or not the framework is valid but it will show whether or not it is a useable tool. To find out if the framework is doing what is intended, it is necessary to state the expectation. The framework designed should assist project managers in selecting an appropriate software development process in accordance with the particular project at hand.

Keywords: Myth, feasibility, framework.

INTRODUCTION

Validation is useful on many levels. The most significant one is often the elimination of risks. The existence of risks is often seen as most important to asses. However, not only for reducing the risk of failure is validation imperative to apply.

Credibility

In this field of research a clear understanding concerning the suitability of software development processes is scarce. There is not a well established theory on which this framework is based on. Decisions made are principally based on interviews and own expertise. These are however partly confirmed by a literature review. Another reason to increase credibility is that in literature as well as in practice, conflicting opinions exist. A highly established author can move one opinion, which is then refuted by a different highly established author. Therefore, to increase credibility, validation is a necessity.

Confidence

For an organization, and even more important the employees within that organization, implementing a change in their comfort zone, their way of working, is difficult. Not only does validation increases the credibility of a designer, but also the confidence from others in the designer and just as important the confidence in yourself. A well executed validation which results in positive conclusions, confirms the added value to the users.

Wider Acceptance

Because of the increase in credibility and confidence, and the decrease in failure possibilities, the design will be widely accepted. A design is only successful if it is actually applied. Support from the organization and their users are of significant importance.

In this research a framework is designed which should assist the project manager to select a suitable software development process based on the characteristics of the project at hand. Three imperative aspects should be questioned in this section of the research. First, a tool should be easy to use and clear for the actual users. They should understand what is expected and which handlings should be executed. The second important aspect is the actual outcome of the framework. When the scales of the characteristics are indicated in the questionnaire, certain processes should result as most suitable to apply. Important to know is if these resulting processes are in accordance with the expected outcomes. If this is not the case, it is interesting to know why they differ. Finally, this validation process should indicate whether or not the framework is usable. Does it have the added value that is expected? Summarized, the three validation questions are:

1. *Is the design of the decision framework appropriate for users?*
2. *Are the conclusions in accordance with the expectations?*
3. *Is the decision framework an appropriate tool to assist project managers in selecting a suitable software development process based on the available software project at hand?*

Multiple validation techniques exist to validate a design. In the first section different techniques are discussed. Furthermore, the three techniques used in this research are explained. In section 1.2 the results of the validation process are discussed. Finally a conclusion regarding the validation of the decision framework follows in section 1.3.

1.1 Validation techniques

Choosing a validation method depends on multiple characteristics of the product and on a number of environmental factors. A very important characteristic is the type of content the to-be validated product has. A model that produces quantitative information should be validated differently than a model that only consists of qualitative information. A quantitative model should be validated by comparing the numbers from the model, with already existing empirical data. Environmental factors have a big influence as well. Especially resources, such as time, people and money can be critical for the amount of possibilities. Next, a number of validation techniques are named:

- Face validation – *Based on look and feel of the models results. This is executed with the help of experts.*
- Trace validation – *An evaluation of each*

possible path in the model. A very strong but time consuming method.

- Bottom-up validation – *A method in which validation starts at the lowest level & very good with bottom-up development.*
- Multistage validation – *Develop assumptions. Compare these assumptions with the validated assumption.s*
- Internal validation – *The distribution of results are compared to the distribution of expected values.*
- Sensitivity validation – *Input variable and initial conditions are changed. The impact on the results are then evaluated*
- Comparison – *This is very useful if multiple models exist. Compare models by evaluating distribution differences*
- Interface testing – *Tests data, model and user interfaces. This ensures correct importing and exporting of data.*
- Graphic display – *Compares the graphical results of the model with the real system. Very similar to comparison validation*
- Turing tests – *An expert evaluates two sets of output data, that of the real world and that of the system. The expert differentiates between the two.*
- Experimental Validation – *Together with users, test and evaluate the system.*

Based on the validation questions stated before three validation techniques are chosen: Sensitivity validation, face validation and experimental validation. These are however not the most effective techniques. Most appropriate would be to apply the framework on an actual project, asses the entire process of developing the project and compare end results with previous similar executed projects. However, because of time restrictions, this technique is within this research not viable. The three techniques selected are however effective enough considering the available resources. The three techniques and the motivation for using these techniques are discussed in the following subsections.

1.1.1 Sensitivity validation

Sensitivity validation is a very applicable tool when no (or limited) case studies are present. Sensitivity analyses entail changing input variables and research the change in output variables. It is important that the output variables do not change extremely when initial conditions are only changed a little.

In this research a framework is developed. To be able to compare the results,

an initial starting point is needed. This starting point corresponds with the average executed projects at POC, and is developed with input from CS. This framework is tested on sensitivity by changing the initial conditions. The framework has two sets of initial conditions which are viable to change. These sets concern the calculation variables, which multiply the score by a certain number depending on the suitability of the process on a particular characteristic and the weights of each characteristic.

The initial scores given to the calculation variables were chosen randomly. It is however important that variable α is higher than variable β and that variable β is higher than variable γ. This should also be the case when changing the variables. The changes concerning the Calculation Variables are the following:

TABLE 1-1 Calculation variables

Variable	Original Value	Test Value 1	Test Value 2	Test Value 3
α	1	1	20	1
β	0,75	0,99	10	0,1
γ	0,5	0,98	1	0,05

An essential difference between the calculation variables and the weights is that the weights are not selected randomly, but are researched and discussed with experienced personnel. The initial weights given to the characteristics are defined by consulting employees at POC. Therefore, these weights should not be changed within this framework. Furthermore, these weights are the basis for the framework. It is understandable that when these weights change, the final outcome will change as well. However, it is interesting to research what will happen to the conclusion if all the weights are equal, which therefore eliminates the weights. Table 1-2 will show the changes made.

TABLE 1-2 Weights variables

Characteristic	Weight Original	Weight Test 1
Project Size	4,1	2
Team Size	2,9	2
Requirements Maturity	4,4	2
Team Relationship	3	2
Client's Commitment	3	2
Scope Clearness	3,3	2
Risk Clearness	3,8	2
Environmental Stability	4,3	2
Stakeholders Flexibility	2,8	2
Method of Contracting	2,9	2
Outsourcing	3,5	2

1.1.2 Experimental validation

A suitable and solid validation method is to introduce the end user to the system. The users can, based on their practical experience, apply the framework as it would in "real-life" and evaluate the results. The method of experimentation by the end user is discussed next. The user of the framework (employees within POC) will have to state the scales for each characteristic. This is done twice. First, the questionnaire is filled in by testing an actual executed project. The user can then compare the software development process actually used for this project with the software development process that resulted from the framework. Secondly, the user has to apply different fictive projects. For example, the user can scale the characteristics according to a small and

innovative project. The results can be compared to the individual expectations (which is based on experience) and evaluated. Not only the result of the framework is interesting, but also the usability factor. It is of the utmost importance that each user understand what is expected from him or her and why. Furthermore, the steps taken by the framework should be understandable.

Three employees within POC tested this framework. The three employees are CS(Product manager XDF within SoDC Call Face NL), Satish(manager of requirements management within SoDC Call Face NL) and finally Mahesh(architect within SoDC Call Face NL). These three are all very familiar with software development and software development processes. Furthermore, they are all involved in executing projects within POC. They can therefore evaluate the results of the framework with previous experiences. Ideally, a high number of users are used. Unfortunately, because of time restrictions of the employees and this research more than three users was unviable.

The questionnaire presented to the users while testing the framework is presented & the results are discussed.

1.1.2 Face validation

Face validation involves experts (knowledge in high extent) regarding the subject. These individual experts were asked whether or not the framework itself and its behaviour are correct. Face validation is very suitable at the early stages of development where an informal review can be highly informative. In this framework certain choices were made, part based on literature and part on subjective opinions. Experts can evaluate these choices. For this method of validation two experts were invited to review the framework. These are Suresh(Manager within SoDC Call Face NL) and RamPrasad (Professor within the department of ICT, TU Delft). These very knowledgeable experts regarding software development and software development processes were asked to evaluate the framework by using it in practice and answering some questions. The face validation questionnaire as well as their answers can be found. These are discussed in the next section

1.2 Validation results

1.2.1 Sensitivity validation

The goal of this method is to change the initial conditions, while analyzing the differences that occur in output or conclusions. When a system is robust, the changes in output will be minimal. The first sensitivity analysis test for this framework is to analyze the conclusion while changing the calculation variables. The graph, and processes with highest and second highest suitability score should be observed. This sensitivity validation consisted of three scenarios. Each scenario has different values for calculation variables. The conclusions of these three scenarios and the original framework conclusion are presented below.

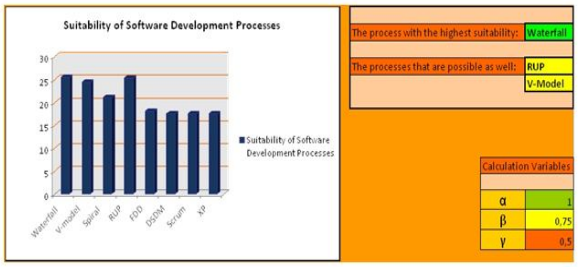

FIGURE 1-1 Conclusion with original calculation variables

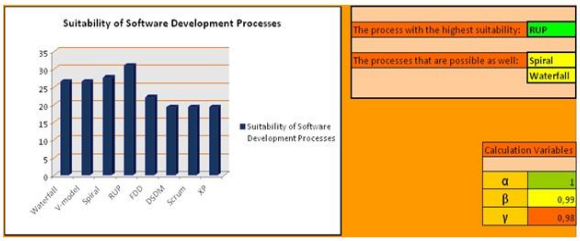

FIGURE 1-2 Conclusion with test value 1

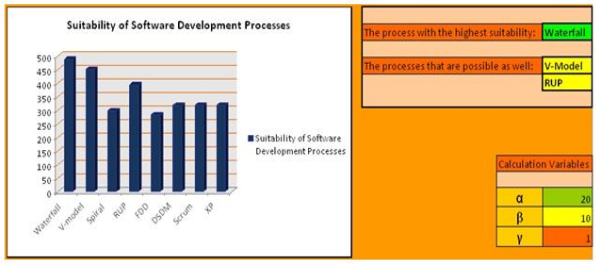

FIGURE 1-3 Conclusion with test value 2

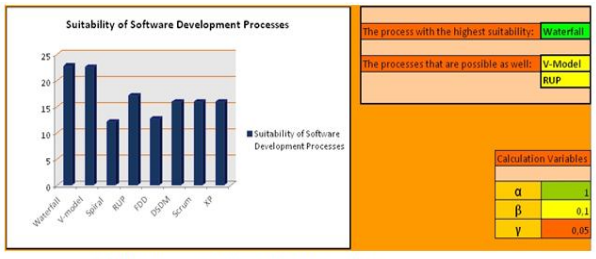

FIGURE 1-4 Conclusion with test value 3

From the first sensitivity analyses it can be concluded that the framework is quite robust. The second and third scenarios show the same results as the original conclusion. The graphs of all three scenarios show a similar behaviour. The only difference is the score each process receives. However, this is consistent with the changes in the calculation variables values. The conclusion of scenario 1 resulted somewhat different. However, the three processes with the highest suitability score are almost similar to those of the other scenarios and the original framework. From this analysis it can be concluded that the actual value of the calculation variables is not that significant. It is recommended to still use the original number because of the balanced ranking of suitability. However, the final users can decide themselves what the actual values will be.

The second sensitivity analysis concerns the weights of each characteristic. Because of the significant importance of the weights to the framework, big changes will not be analyzed. However, it is interesting to find how much influence the current weights have on the final score. Therefore, all the weights are equal. The results of this analysis is shown in figure 1-1. In figure 1-5 the original conclusion is depicted.

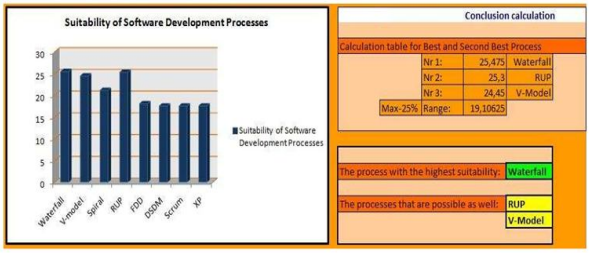

FIGURE 1-5 Conclusion with original weights

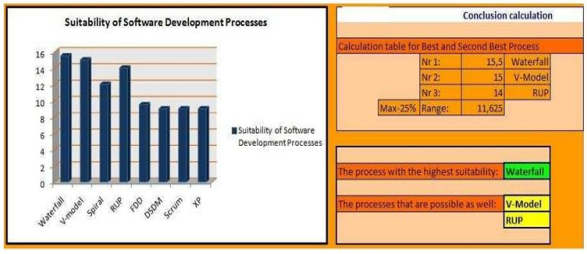

FIGURE 1-6 Conclusion with all equal weights

This validation test shows that the current weights are not of a significant influence. It is obvious that when the weights are changed extremely, the result will as well. However, figure 1-6 shows that when the weights of all characteristics made equal, no significant changes occur to the final result.

1.2.2 Experimental validation

The experimental validation consisted of three subjects who used the framework and commented by filling in the questionnaire presented. Each of the three subjects experimented with the framework by applying it to different projects. In this subsection three projects are discussed, one of each subject. This subsection is structured in three parts, each discussing the results and comments of one particular subject.

Sudeep Chand (Product manager XDF within SoDC Call Face NL)

Mr. Sudeep is an experienced user of software development processes and is familiar with the projects executed in the organization of POC. He is especially experienced in RUP. For this validation experiment this subject applied the framework to a project which is especially feasible for RUP, thereby testing the framework on its accuracy. The project characteristics are stated in table 1-3.

TABLE 1-3 Experimental project Ed van Kooten

Project Characteristic	Scale	Project Characteristic	Scale
Project Size	3	Risk Clearness	2
Team Size	3	Environmental Stability	2
Requirements Maturity	2	Stakeholders Flexibility	2
Team Relationship	4	Method of Contracting	Time/Material
Client's Commitment	3	Outsourcing	Yes
Scope Clearness	2		

This project was, according to the respondent, a typical project for applying RUP. This project was tested on the framework and the following conclusion was made (figure 1-7). The conclusion of the decision support framework clearly corresponds to the expectations of the subject. However, this validation does not consist solely of testing the result. The respondent had the possibility to give comments on the entire framework, i.e. the design, usage, set-up. These comments are discussed next.

Positive remarks:

The respondent found the questionnaire to be well-organized. This was also a remark regarding the conclusion tab. The different approaches of showing the suitability of the processes was appreciated. Furthermore, the conclusions of the experimental projects were according to the respondents expectations. The respondent stated that this decision support framework is a very useful tool for starting projects. "It triggers the user to think about the project. Now, projects are often started without even having analyzed what the project actually contains".

Suggested improvements:

The respondent also had some comments for improving the framework. The first part of the framework consists of a questionnaire. The scales used were not clear for the respondent. The following example was given: "For a certain user, who is often involved in smaller projects, a project of 200.000 Euros could be extremely big, while for someone else, this would count as an average sized project." The respondent therefore suggested to use absolute numbers to indicate the scales. A different comment was that he missed an explanation. The framework should be a tool on its own, and useful without the report. Furthermore, this explanation should prevent users to interpret the framework differently. Finally, he commented that although the characteristics of the project are all very viable, relationships among these characteristics are missing. As example the respondent gave the following: "If the risks of a project are very unclear, other characteristics might change." The respondent did indicate that the possibility of changing weights is a very important aspect, because when the risks are very unclear, this characteristic might become significantly more important than it is when the risks are very clear.

H K Malhotra (Architect within SoDC Call Face NL)

The second respondent for this validation phase is Mr Malhotra. He is employed as an architect and is therefore involved in the beginning of many projects. Furthermore, he is very knowledgeable concerning software development processes. The project stated next (table 1-4) represents the average project he conducts.

TABLE 1-4 Experimental project Wouter Blokdijk

Project Characteristic	Scale	Project Characteristic	Scale
Project Size	2	Risk Clearness	2
Team Size	2	Environmental Stability	2
Requirements Maturity	2	Stakeholders Flexibility	4
Team Relationship	4	Method of Contracting	Fixed Pricing
Client's Commitment	4	Outsourcing	Yes
Scope Clearness	3		

For this particular project the respondent commented that he expected an iterative process to be most suitable. Furthermore he mentioned that the Waterfall model was most likely to be the least suitable. The conclusion, presented in figure 1-8, is in accordance with the respondents expectations. FDD, RUP and DSDM are all processes which use iterative development. The respondent commented that he is familiar with DSDM and RUP and knows that these two are indeed viable for this particular project. Other comments are presented next.

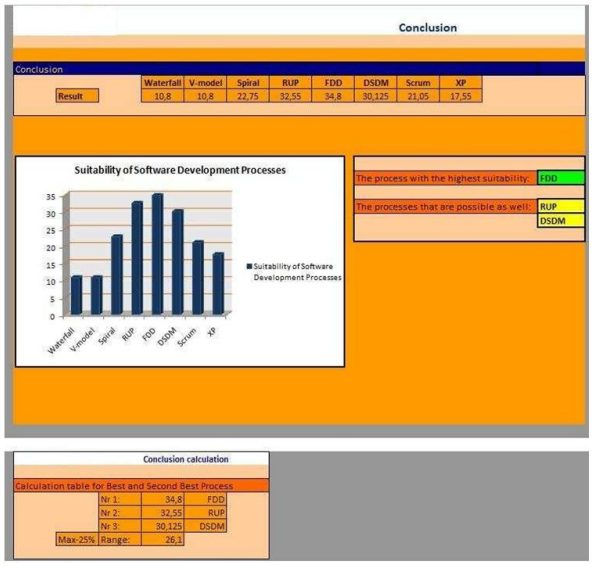

FIGURE 1-8 Conclusion experimental project

Positive remarks:

The approach used for this framework is, according to the respondent, appropriate. While doing projects, he experienced that projects were executed without actually analyzing the characteristics of that project. This framework triggers the user to think. Furthermore, this framework can be used as a tool to convince not only yourself for using a certain process, but even more important, the client.

Suggested improvements:

The respondent also commented that some improvements are advised. While using the questionnaire form in the framework, the respondent noticed that the scales are not clear. Absolute numbers to indicate *Project Size* and *Team Size*, would be safer. An other issue he encountered was that some characteristics were unclear. To prevent own interpretation these should be adjusted. Especially the characteristic *Environment Stability* was mentioned. The respondent commented that this could be solved by adding an explanation tab, in which the entire framework is elaborated on. Finally, he noticed that some processes were unknown to him. In this particular experiment, FDD turned out to be most suitable. However, the respondent was not familiar with this process. He suggested to add a linking page to give the user the possibility to get more information regarding that particular process.

Subhashish Shashank (Manager of requirements management within SoDC Call Face NL)

The final respondent used for the experimental validation was Mr. Shashank. This respondent is as manager of requirements management, intensely involved in the starting up of a project and even more important, the evaluation of the project. Therefore this respondent has significant knowledge concerning projects performed at POC and their results. Testing this on the framework is very interesting. Furthermore, this respondent has partly introduced RUP into an organization in which only the Waterfall model was used. She is knowledgeable concerning software development processes. The project that this respondent tested on the framework was a project executed earlier this year by POC. As is shown in table 1-5 this project can be considered as very large with many uncertainties.

TABLE 1-5 Experimental project Christien Bergman

Project Characteristic	Scale	Project Characteristic	Scale
Project Size	5	Risk Clearness	2
Team Size	5	Environmental Stability	1
Requirements Maturity	1	Stakeholders Flexibility	4
Team Relationship	2	Method of Contracting	Time/Material
Client's Commitment	3	Outsourcing	Yes
Scope Clearness	1		

For this particular project the respondent reacted very surprised (Figure 1-9). According to the respondent, this particular project was a failure. The project was too big, and the uncertainties were too great. However, they still executed the project. If this was tested on the

framework other conclusions might have been taken. Figure 1-9 shows the extreme conclusion regarding this project. This conclusion could be seen as a fault of the framework. However, the respondent commented that this conclusion was very clear. For her, it became clear that this particular project could not be executed. Because of the extreme uncertainties, agile processes, such as Scrum and XP were most suitable. However, the size of the project created a difficulty for agile processes and was more suitable for the Waterfall process. The respondent stated that, according to this result, the project should either be separated into smaller components, in which agile processes suffice, or the uncertainties should be resolved to create more suitability for the Waterfall model or RUP .

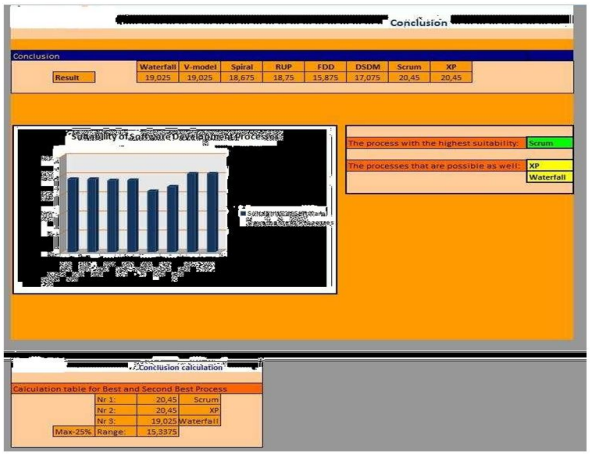

FIGURE 1-9 Conclusion experimental project Mahe

Positive remarks:

The respondent commented that, when initiating the framework, the style was in accordance with ING and therefore easy to use. Furthermore, the weights gathered from a survey were, according to the respondent, imperative. This will make sure users will not apply their own personal feeling into this framework. After experimenting with the framework, she commented that, in her opinion, the framework was correct. The processes she expected, based on her own experience, resulted as suitable. According to the respondent, this framework is very easy to use and accessible. She commented that it is a "real eye opener". Especially for increasing understanding and creating a certain image it is very useful.

Suggested Improvements:

As with other respondents, she commented that more explanation was needed regarding the framework, the characteristics and the usage of the framework. Furthermore, she commented that it would be interesting to include some sort of "red flag". For example: If every characteristic scores agile, except for the *Project Size* (which is very large and thus scores the Waterfall model), a certain warning should be stated which alerts the user for this particular issue. This will inform the user that, although Scrum scores most suitable, the user should consider the project size before taking this actual decision.

1.2.3 Face validation

Besides experimental validation, face validation was conducted. Two experts on this area were asked to test the framework and answer some questions. This was conducted to get in-depth information regarding the

correctness and usability of the framework. The questions asked are presented in Appendix VII. For this validation element the focus was on two aspects:

1. Are the results according the experts expectations?

2. Is the framework appropriate and useful for large organizations?

The first issue that came across was the lacking of information. Each characteristic should be thoroughly explained to prevent individual interpretation. Furthermore, the questions asked in the questionnaire are not clear. It is recommended by both experts to include an extensive information sheet which explains each element of the framework and the steps taken. One expert recommended to include information "clouds" which will appear when scrolling over a particular element of the framework.

The second issue that was mentioned by one of the experts was the lacking of interdependency between characteristics. In this framework each characteristic is discussed individually and processes are mapped on each characteristic individually as well. According to the expert, it could be possible that a certain characteristic changes when a scale of another characteristic is changed. It is recommended by the expert to research these interdependencies and include them in the framework.

On the final conclusion on the usability of the framework both experts were positive. They both stated that for a software project, such a tool would be a great benefit. One expert commented that the insight you get of the project is of great importance. By using this tool, the user is confronted with the characteristics of a project. By thoroughly analysing and discussing these characteristics the view and knowledge about the project are significantly increased. One expert tested a project conducted & also this test was successfully completed according to the expert. This shows that the framework is suitable outside of POC and the financial market.

1.3 Validation Conclusions

The overall validation result is positive concerning the framework. In the introduction of this chapter, three main validation questions were stated. These were:

1. *Is the design of the decision framework appropriate for users at POC?*
2. *Are the conclusions in accordance with the expectations?*

3. *Is the decision framework an appropriate tool to assist project managers in selecting a suitable software development process based on the software project at hand?*

Three validation methods were conducted to test the framework: Sensitivity validation,

experimental validation and face validation. The sensitivity validation focused on the sensitivity of the suitability scores and weights. This can be concluded as a positive result. Changes in the suitability scores as well as the changes in the weights of each characteristic did not (or minimally) effect the final conclusion of the framework.

The other two validation methods resulted in very useful comments. From these two methods it is possible to conclude that the framework is indeed an useful method for analysing the project at hand, and finding an appropriate software development process. This was concluded by all interviewed users and experts. The major point of interested was, according to the users, the fact that the framework triggers the user to actually think and analyse the project. Furthermore, the possibility to communicate this with the client is a significant advantage. A different interesting aspect was the test. In this test the framework concluded that almost all software development processes are suitable. This indicates that the project is not specified thoroughly enough. This can be a positive influence on group discussion and negotiation.

Besides the positive general view on the framework, some helpful recommendations were stated as well. First of all, it became clear that the framework needs additional usage information. All users agreed that individual interpretation should be avoided. Secondly, the usage of scales was perceived to be a useful method, however the lack of indication of what each scale means was found to be a difficulty. A different suggestion was to include some sort of warning system: If a process is suitable on all characteristics except one, this should be notified to the user. The final recommended improvement was to include interdependencies between the found characteristics.

Based on the results of the total validation process some changes were made to the framework. The most significant changes are the dependencies that are included between Team Size and Team Relationship and between Requirements Maturity and Scope Clearness. The info tabs which explain the necessary steps in the framework and the processes, and the warning element which indicates when the most suitable process does not score at all on one more characteristic(s). It can be concluded that, after these changes were made, the framework is a useful and helpful tool for large scale organizations involved in developing software.

As was mentioned in the introduction of this chapter, this research is limited in time. It is therefore recommended to start with an ongoing validation process of testing and fine-tuning the framework. One of the most significant validation methods is comparing the execution and delivering of projects that are executed with the help of the framework with projects that did not.

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