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Focus on Non-Functionals! The Effect of Focussing on Non-Functional Requirements on the Maturity of the Requirements Engineering Process

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ABSTRACT

When developing IT systems it is important to know the requirements of the system. Requirements can be classified into different categories. In this study we look at functional and non-functional requirements. Respectively these describe the behaviour of the system (functional requirements) and the criteria under which the system works (the non-functional requirements). Furthermore this paper contributes to the understanding of the relation between the focus on non-functional requirements and the maturity of the requirements engineering process. The research question this paper addresses is: "How does the focus on non-functional requirements influence the maturity of the requirements engineering process?" The method of the International Requirements Engineering Board is used as the standard for the requirements engineering process. Based on this a questionnaire was developed to measure both the maturity of the requirement engineering process and whether non-functional requirements are taken into account or not. This questionnaire was then sent to a population of people with an IT function, like IT architects and developers. 69 people from different organizations participated in the survey; of this 65 responses were valid and used for the analysis. The results of the analysis show that there is a positive correlation between the focus on non-functional requirements and the maturity.

Keywords: Non-functional requirements, functional requirements, requirements engineering, maturity, nfr, re

INTRODUCTION

In December 2014 the digital news agency NU.nl headlined an item related to security: "The digital public authentication service DigiD was hit by an outage. Possibly the problem is the large amount of people who want to log in with their healthcare insurance-provider, because switching is possible until Wednesday." (Poort, 2014). Just over a month later another IT security failure made

the Dutch news: "The failure that took place yesterday on the websites of Rijksoverheid.nl, Telfort and GeenStijl was caused by a DDoS attack, as the government says. The attack targeted network provider Prolocation began yesterday morning around 10:00 and lasted well into the evening" ("Storing Rijksoverheid.nl", 2015).

These are a few examples of incidents, which happened in the Netherlands in just a short time span. All of the incidents have to do with information systems, in which the non-functional requirements (NFRs) are not or have not been sufficiently taken into account, so the information systems do not respond as they should respond in certain situations. Had this been taken into account during the development of the systems, then these incidents had no or much less caused problems.

A better focus on the NFRs could mean a higher maturity of the requirement engineering (RE) process. However it is unclear whether this can actually be measured. Also there is no prior research that shows that there is a positive correlation between the focus on NFRs and the maturity of RE. Therefore in this research the following question is proposed: "How does the focus on non-functional requirements influence the maturity of the requirements engineering process?"

CONTEXT AND THEORY

Mastering the Requirements, called RE, is an important process in the development of IT systems. The better the requirements are determined and included in the process, the better the final solution is connect to the needs of the business or client. Multiple studies, (Hofmann & Lehner, 2001; Verner, Cox, Bleistein, & Cerpa, 2007; Zakaria, Haron, Sahibuddin, & Harun, 2011) have shown that good RE makes a positive contribution to the results of IT projects. Adjustments are often much more expensive than if they were included in the primary development, (Bremmer, 2009; Wiegers, 2000).

To get a better integral picture of the solution consisting of both functional requirements (FR) and NFR should be addressed in the development process. They should get focus and be sought out with the stakeholders who can articulate these requirements, as indicated by Glinz and Wieringa (2007). In addition to the requirements should jointly be described in order to see the consistency (Alexander, 2003). During the RE process much time is spent on the FR but often insufficient attention is paid to the NFR ((Chung & do Prado Leite, Julio Cesar Sampaio, 2009; Glinz, 2007)), so the final solution does not match enough with the needs of the customer, (Solemon, Sahibuddin, & Ghani, 2012; Verner et al., 2007; Zakaria et al., 2011).

This can cause problems, such as:

- Unnecessary additional work on an application that is too slow.
- Fewer customers due to limited availability.

The maturity of an IT development company with respect to the requirements engineering process gives an indication of how well this process is being addressed and standardized ("The requirements maturity model explained", 2014). However, the questionnaire as described in ("The

requirements maturity model explained", 2014), is positioned at a higher level than needed to get a good picture of the requirements engineering process for the FRs and NFRs.

Here we use a requirements engineering method called IREB ("International Requirements Engineering Board", (Pohl & Rupp, 2011)). IREB consists of four different steps, which are addressed in a cyclic process:

- Requirements elicitation
- Requirements documentation
- Requirements validation and negotiation
- Requirements management

Each of these steps has got its own specific focus on parts of the RE. The first part within the RE process, the requirements elicitation, is the stage where the actual requirements are collected from the various stakeholders. "A stakeholder is a person or organization that affects the requirements of a system or influenced by that system." (Glinz & Wieringa, 2007). This influence can be either direct, within the project, or indirect, outside the project. The next step is describing or documenting the requirements of a system or component. This is also important because it is the basis for the actual development of the system. In addition, these requirements may have a legal relevance, particularly when there is a difference of opinion between the client and the contractor in executing the project. Therefore, it is prudent that the requirements should be accessible to all interested parties.

After capturing, the requirements should be validated and negotiated. The purpose of validation is particularly the identification of anomalies and troubleshooting the documented requirements, such as ambiguity, incompleteness and inconsistencies. The purpose of negotiating is to get a common and agreed understanding of the requirements of the system to be developed with all stakeholders. Managing the requirements will guide the elicited, documented and validated negotiated requirements through the process. Management involves prioritization, traceability and managing requirements change.

In each of these steps it's possible to point to specific parts where focus on NFR should be addressed to get an optimal situation. When this is plotted in a framework, the following conceptual model can be formed (see Figure 1).

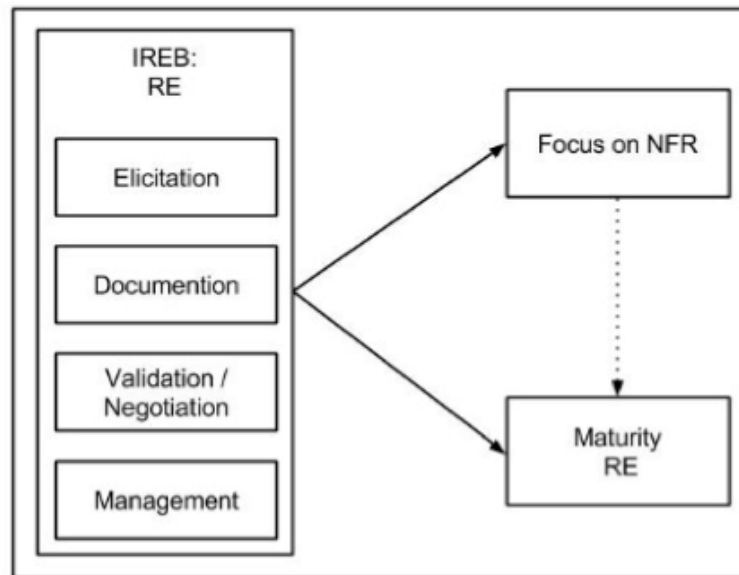


Figure 1: Conceptual Model.

In this case, the focus on NFR is the independent variable. The maturity of RE is the dependent variable.

DATA COLLECTION

To be able to measure both the maturity of the RE proces and the focus on NFRs, a measurement tool was needed. Using the theory of IREB a questionnaire has been developed which addresses both. The questionnaire was build up from scratch, by analysing the IREB study guide “Requirements Engineering Fundamentals”, attending an IREB course and using the literature that was found about requirements engineering. It has multiple questions, varying from 2 to 6 for every step in the RE process and specific questions for the focus on non-functional requirements, which gave a total of 30 questions. For answering these questions a Likerd-scale is used, varying from ‘not applicable’ to ‘highly applicable’. The answers where calculated into values from 0 until 5, where 0 means ‘not applicable’ and 5 ‘highly applicable’.

This questionnaire has been tested on several subject matter experts, like (in-)direct colleagues and a IREB-teacher, by inviting them to fill in the answers for their situation and asking for feedback, which they were willing to give. Their feedback was used to finalize the questionnaire and make it ready for further distribution.

The target audience for the questionnaire was architects, requirements engineers or software developers, who are working at an IT development company. As a source for the target audience, LinkedIn connections were exported and filtered to get email-addresses from people with the right job description and company branch. This resulted in a total of 180 available and usable mail-addresses. The questionnaire was emailed to these connections. Also the questionnaire was posted on the website of NGN-Ngi. After 3 weeks, 65 of had filled in the questionnaire properly. There were four incomplete reactions, which were discarded from further analyses.

The average was taken on the answers on the different questions per step for the maturity and focus on NFR. Also the total average for both variables was calculated. From these values the Cronbach's alpha (Cronbach, Lee J, 1951) is determined to show if the answers can be combined into single values. The calculated Cronbach's alpha for the requirements engineering maturity is 0.846 while that for the focus on NFR is 0.817. If the value for Cronbach's alpha is higher than 0.70, the values of the different answers can be averaged into a single value, without having to have a less reliable research. In this case the Cronbach's is higher, so the average value for the focus and maturity can be determined.

RESULTS

The results taken from the survey are analysed to get more information about the relation between focus on NFR and maturity of RE.

The scatter diagram below (figure 2) shows that there is a correlation between the two variables. The points on the graph are distributed around the trend line. There can also be seen that it is a positive correlation. However, it is a partial correlation, since not all the points are on one line but scattered around the line. There are a limited number of coordinates which are noticeably outside the cloud. The values are about up to 1 point of the trend line, into a compact cloud.

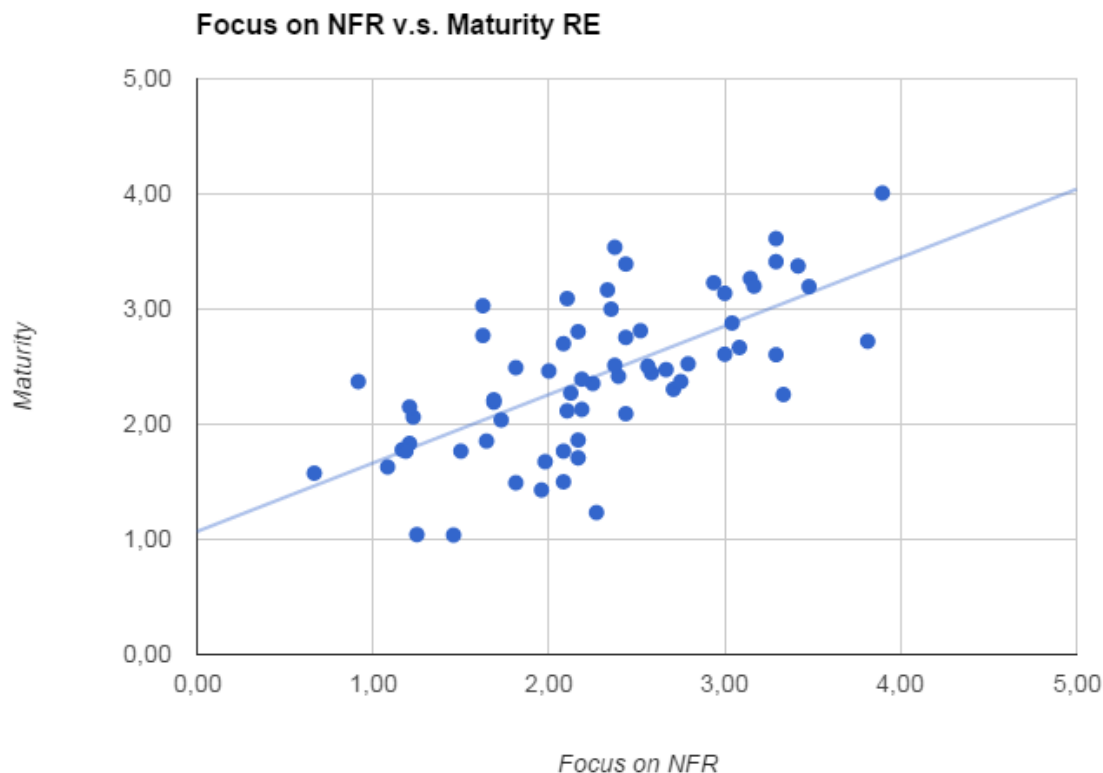


Figure 2: Scatter Diagram NFR versus RE maturity.

Also the correlation coefficient was calculated for the different steps, which gives an indication of the direction and the cohesion of the two variables.

		Maturity				
		Elicitate	Document	Validate and negotiate	Management	Maturity RE
Focus	Elicitate	0,3528	0,5232	0,5897	0,2131	0,5026
	Document	0,4663	0,5489	0,5285	0,4388	0,5972
	Validate and negotiate	0,4154	0,5292	0,6896	0,3892	0,6096
	Management	0,2731	0,3301	0,4917	0,3532	0,4388
	Focus NFR	0,4626	0,5916	0,7162	0,4342	0,6641

Table 1: Correlation analysis of the different relations.

The most important relationship here, is the relationship between the maturity of the RE process and the focus on NFR. Since the value of the correlation is 0.66, it means that there is a moderate and positive relation. It can be concluded that companies with a higher focus on non-functional requirements, the maturity of the requirements engineering process is often higher than at companies with less attention.

The regression analysis determines whether there is a relation, on the basis of the correlation of the independent variable (the attention for non-functional requirements) and the dependent variable (the maturity of the requirements engineering process). The simple linear regression analysis using continuous or ordinal data. In this study, there is made use of continuous data. Linear regression is clearly explained by Professor de Haan (Haan, 2014). The Linear Regression function is applied. This function has a number of parameters which are dealt with below.

Parameter Linear Regression:

- Input Y Range: This is the dependent variable, namely the maturity of the requirements engineering process.
- Input X Range: This is the independent variable, namely the focus on non-functional requirements.

Regression Statistics	
Multiple R	0,6642363314
R Square	0,4412099039
Adjusted R Square	0,4323402199
Standard Error	0,4957207292
Observations	65

Table 2: Regression Statistics.

The above table shows that there was a moderate correlation between the two variables, by the value of R Square. This value, 0.44 (in a percentage: 44%), indicates that almost half of the variation of the maturity can be explained by values of the attention for non-functional requirements. 56% Cannot be explained. The standard error Standard Error in the above table indicates the deviation of the sample mean. This value is quite high, this is due to the limited number of respondents. The measurement is therefore of limited reliability. In a subsequent study, the number of respondents should be more extensive.

By means of regression analysis can be determined whether and to what extent a given variable can be explained by a different variable. In this study we look at linear regression. The ANOVA (analysis of variance) is widely used for this purpose.

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	12,22394147	12,22394147	49,74358734	0,00000000161607483
Residual	63	15,4815596	0,2457390413		
Total	64	27,70550107			

Table 3: Anova statistics.

The analysis indicates that the significance F is <0.05 . This means that there is a significant difference of the null hypothesis is. The null hypothesis is the hypothesis which states that there is no relationship between attention and maturity. This hypothesis is rejected by this low significance. The model, which assumes that focus on non-functional requirements it is related to maturity of the requirements engineering process is significant and therefore applicable.

CONCLUSION AND DISCUSSION

After completing the survey and the analysis of the data, a moderate and positive correlation between a focus on NFR and the maturity of the RE process has been identified. This is because of the value of 0,66 for the calculated correlation analysis. Also regression statistics show that there is a moderate correlation between the two variables. 44% Of the variation of the maturity can be explained by values of the attention for non-functional requirements.

In other words, there is a significant relationship between the attention paid to non-functional requirements and the maturity of requirements engineering. This relationship has a moderate level and is positive. It is therefore reasonable to assume that a company with a high attention non-functional requirements has a high maturity with regard to requirements engineering. And, as previously indicated, a high maturity gives better results in IT projects. This means that if more attention is paid to NFR, a higher maturity of RE is expected. As in other studies it has been shown that a higher maturity of the requirements engineering process yields better IT projects, it can be concluded that more focus on NFR will make a positive contribution to the outcome of IT projects. So focus on the non-functional requirements!

During this research some concessions had to be made because of the tight schedule. For future research, the size of population should be larger and more divers. As mentioned, the source for the addressed respondents was an export of LinkedIn-connections and a posting on the NGN-Ngi-site. Because of these sources it was not possible to get a well spread variety of respondents. Also because of the small number of respondents, the calculated values for the statistics are less accurate, than with a larger population. Therefore this research can only be used as an indication and an input for further research.

This research mainly focussed on the process of requirements engineering and less on the stakeholders, the business. The business, however, hasn't got a lot of knowledge about non-functional requirements, as indicated by several respondents. For future research, this could be a different view on defining, implementing and use of non-functional requirements from a business perspective.

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