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Intention to Adopt Non-Functional Requirements: Determinants and Consequences of Perceived Value and Perceived Risk

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ABSTRACT

The objective of this paper is to examine software engineers' intentions to adopt Non-Functional Requirements (NFRs). Examining software engineers' evaluation of the perceived value and perceived risk of NFRs is the important factor of this study. Determinants of perceived value and perceived risk judgments were proposed and tested in order to determine what factors are influencing software engineers' intention to adopt NFRs, which include perceived self-efficacy, management support, perceived complexity, and perceived cost of NFRs. A structural equation model (SEM) was applied to analyze the data. The results showed that perceived utilitarian value and hedonic value had significant influence on software engineers' intention to adopt NFRs. Perceived risk was not found to have significant direct effect on adoption intention, but it significantly impacted utilitarian value judgment. Among the proposed determinants, perceived self-efficacy was found to have the largest impact on both utilitarian value and hedonic value, whereas perceived complexity was found to have the largest impact on perceived risk. This study contributes to a theoretical understanding of the factors that promote NFRs adoption on the individual level and suggests practical implications for system development managers to promote software engineers' willingness to work on NFRs.

Keywords: Adoption intention; Non-functional requirements; Perceived risk; Perceived value

1. Introduction

Software requirements elicitation is an important and essential pre-requisite to the subsequent phases in the software development lifecycle. Many software development analysis and designs

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primarily focus on functional requirements (FRs) but pay less attention to non-functional requirements (NFRs) such as performance, capacity, usability, security, and scalability, despite the fact that NFRs are often more critical than individual FRs in the determination of a system's perceived success or failure [1]. NFRs are normally hidden somewhere in the software specifications, or mentioned in the form of comments or special requirements. As a result NFRs frequently are ignored or even overlooked. It has been observed that the corrections of NFRs are much more expensive and difficult to correct [2]. NFRs are usually documented separately from functional requirements, without quantitative measures, and with relatively vague descriptions. As a result, they remain difficult to analyse and test [3].

Perceived value and perceived risk are the important concepts to understand individuals' intentions to adopt a certain innovation. Perceived value and perceived risk have been found to be studied together in many recent IT researches. However, little or no research has been conducted to address perceived value and perceived risk of NFRs by software engineers who are involved in software development.

Though NFRs have been shown to be important, many studies stated that they have often been neglected and not considered adequately in software development [1-6]. For this reason, this study is interested in finding the important factors that affect software engineers' perceived value and perceived risk of NFRs, and how those factors influence software engineers' intention to adopt NFRs. The questions can be summarized as follows:

Question 1: What are the important determinant factors of software engineers' perceived value and perceived risk of NFRs?

Question 2: How do perceived value, perceived risk, and their determinant factors influence software engineers' intention to adopt NFRs?

The following sections present a comprehensive review of previous related studies. In particular, this review presents the motivation for the variables and their relationships which are included in a theoretical model.

2. Literature Review

2.1 Non-Functional Requirements (NFRs)

NFRs are requirements which are not directly concerned with the specific functions delivered by the system [7]. NFR in software system engineering is a software requirement that describes not what the software will do, but how the software will do it [6]. They are referred to as quality requirements and represent software requirements that describe how software should perform [4]. FRs sketch out the functionality, the system has to perform while NFRs compel the restrictions on this functionality [2]. They include observable qualities such as system performance, availability and dependability, and also internal characteristics such as maintainability and portability [8].

Vermeulen et al. [9] studied 65 people who are working at an IT development company. The study concluded that in companies with a higher focus on NFRs, the maturity of the requirements engineering process is often higher than at companies with less attention. Caracciolo et al. [10] interviewed 14 software architects, managers, and developers and found that most NFRs are not formally specified; the use of automated techniques for validating quality requirements is not commonplace; tool support for automated validation is insufficient; quality attributes that have been most frequently encountered in past work experiences generally do not have a significant impact on the outcome of an industrial project. Ullah et al. [2] stated that NFR is an important concept in the

requirements engineering which plays an essential role in the success or the failure of a system. Unfortunately, NFR concerns are normally dealt with at design and implementation levels and this approach results in the failure of most of the systems. The study of Haigh [11] asked 318 respondents to rate the importance of each of 13 widely-cited attributes related to software quality. The survey revealed significant differences between the priorities assigned to a number of attributes by holders of different roles for several attributes: usability (favored by users), accuracy (favored by managers of users) and testability and maintainability (favored by development staff).

2.2 Theories relevant to adoption intention

An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption [12]. Innovation adoption may be defined as "new to the adopting unit" [13]. Newness in an innovation need not just involve new knowledge. Someone may have known about an innovation for some time but not yet developed a favourable or unfavourable attitude toward it, nor have adopted or rejected it [12]. Adoption Intention is the degree of the psychological state of the people's general minds to adopt specific innovation [14]. The same innovation may be desirable for one adopter in one situation but undesirable for another potential adopter in a different situation [12].

Perceived value is an important concept for understanding individual behaviours such as innovation adoption. Perceived value is a polymorphic concept that has been widely discussed in several disciplines like marketing, psychology, sociology, economics, etc. [15]. Perceived value is the individual's overall assessment of the utility of an innovation based on perceptions of what is received and what is given [16]. Perceived benefit can be divided into extrinsic and intrinsic benefits. Extrinsic benefits are functional, utilitarian or banausic; in contrast, intrinsic benefit perceptions result from fun and playfulness for their own sake [17]. An approach to utilitarian value alone is inadequate to explain consumer's perceived value thoroughly. Thus, the approach to examining consumption value in the present study was that of utilitarian value and hedonic value [18].

Utilitarian value is instrumental, task-related, rational, functional, cognitive, and a means to an end [19]. Utilitarian value involves more cognitive aspects of attitude, such as value for the money and judgments of convenience and time savings [20]. Individual behaviour driven by utilitarian value is typically satisfying a functional or economic need and is weighted on task completion [21].

Hedonic value is more subjective and personal than utilitarian value. It is the experiential and emotional motivations of consumer behaviour that can be derived from the multisensory, emotive, and entertainment aspect of experience in the consumption process [21]. A hedonic experience, at its extreme, is more subjective and is associated with higher levels of enjoyment, which result in positive moods and higher levels of satisfaction. A hedonic encounter can involve greater interaction, heightened arousal, higher involvement and perceived freedom [22].

Perceived risk has been found to be studied together with perceived value in many researches [14, 17, 23-24]. Perceived risk is the individual's perception of the uncertainty and adverse consequences of adopting NFRs. Therefore, when an individual's perception of risk for adopting something is high, their likelihood of using it will be low [17, 25]. Perceived risk is an important factor and it is necessary to be studied to know the decision making criteria of adoptors [26]. Innovations perceived as most rewarding and involving least risk and

uncertainty should be accepted most rapidly [12].

3. Research Model and Hypotheses Development

Several previous studies have shown that top management support is a significant predictor of IT adoption and leads to more successful IT use in many organizations [27-29]. It is important to create a supportive climate and adequate resources for the adoption of new innovations. Top management would be able to identify business opportunities for the exploitation of IT and their active involvement and support would provide appropriate strategic vision and direction for the adoption of new innovations [28]. Top management support gives well-founded directions within the organization. Management can help to reduce any political interruption, and ensure sufficient resources for implementation [29]. Management support would also send signals about the importance of the innovation and succeed in overcoming organizational resistance to accepting the IS. As a result, management support will lead to obtaining necessary assistance related to capital spending and labor support required and the cooperation to compete for resources in the project-planning and development stage [28]. This study proposes the following hypothesis:

H1a: Management support positively affects the hedonic value of NFRs.
H1b: Management support negatively affects the perceived risk of NFRs.

Self-efficacy affects what behaviors people choose to perform, the amount of effort they are ready to use, and the amount of time they will persist to overcome obstacles [25]. Self-efficacy is important to the concept of hedonic consumption [22]. Individuals will tend to enjoy behaviors they feel they are capable of performing and dislike those they do not feel comfortable with [30]. People who have a higher self-efficacy are likely to have more positive usefulness and ease of use beliefs [31]. This study focuses on whether individuals believe that they have the required knowledge, skill or ability to adopt NFRs and therefore proposes the following hypothesis:

H2a: Perceived self-efficacy positively affects the hedonic value of NFRs.
H2b: Perceived self-efficacy positively affects the utilitarian value of NFRs.

NFRs are characterized as hard to define, and are often given less priority and usually not documented [4]. Perceived complexity is important because for users to follow the structure and achieve their aims, barriers need to be overcome in order to attain utilitarian consumption [22]. Complexity has been widely assumed to be negatively related to innovation adoption. [32]. The study of Yim et al. [33] showed that complexity and risk are associated. Therefore, this study proposes the following hypothesis:

H3a: Perceived complexity negatively affects the hedonic value of NFRs.
H3b: Perceived complexity negatively affects the utilitarian value of NFRs.
H3c: Perceived complexity positively affects the perceived risk of NFRs.

In many circumstances, a project team is pressured to find a way of delivering the required functionality for less cost. This downward pressure on the project costs is likely to result in less attention being paid to the NFRs which impact the operational costs and the change management costs later [5]. Perceived cost can be associated with risk [34], and perceived cost is assumed as the antecedent of perceived value from negative perspective [35]. Xu et al. [36] confirmed significant correlation between cost and perceived risk. Therefore, this study proposes the following hypothesis:

H4: Perceived cost positively affects the perceived risk of NFRs.

Several studies have also shown that perceived usefulness and perceived enjoyment are main components of extrinsic and intrinsic benefits, respectively [17, 21]. Utilitarian value comes from instrumental and functional benefits [37]. Utilitarian value is related to the task-specific, efficient, and economical aspects of products or services. Utilitarian value incorporates cognitive aspects of attitude, such as the economic value for money and judgments of convenience and time savings [38]. Hedonic value is an individual affective and emotional response and results from fun and playfulness [39]. Hedonic value is defined as an overall judgment of experiential benefits and sacrifices, such as entertainment and escapism [20]. Utilitarian value reflects task-related worth, while hedonic value reflects the enjoyment of working on NFRs. Many studies found that utilitarian value and hedonic value are representative benefits by adopting innovative IT products [22-23, 38]. Therefore, this study proposes the following hypothesis:

H5: Hedonic value positively affects the intention to adopt NFRs.
H6: Utilitarian value positively affects the intention to adopt NFRs.

Perceived risk reflects user perception of uncertainty factors during the adoption of NFRs. It is argued that NFRs can have an impact on the managerial success dimension as well. NFRs are realized through architectural designs, which makes, for instance, a change relatively difficult and costly. When an individual's perception of risk for adopting something is high, their likelihood of using it will be low [17, 25]. Perceived risk is an important factor and it is necessary to be studied to know the intention to adopt NFRs by software engineers. Therefore, this study proposes the following hypothesis:

H7: Perceived risk negatively affects the intention to adopt NFRs.

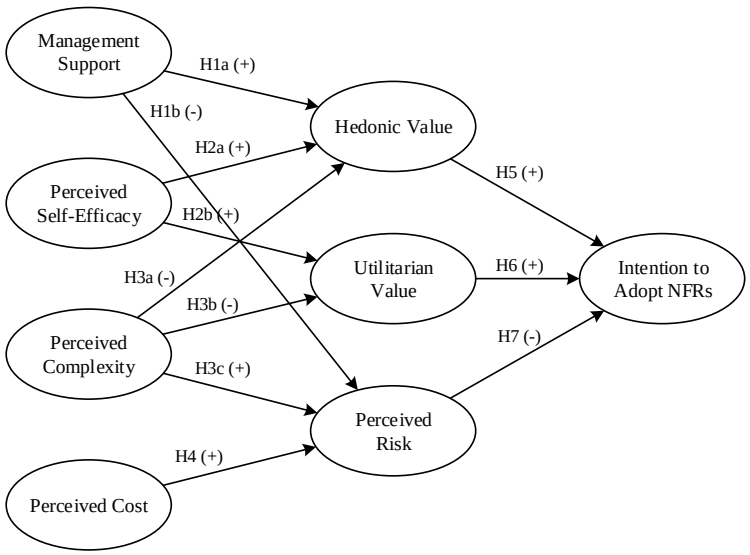


Fig. 1. Theoretical Framework.

The theoretical framework, illustrated in Fig. 1, is strongly influenced by the models developed and tested in previous studies, and has been notated to identify the 11 research hypotheses associated with the hypothesized causal relationships among the variables. All of the analysis and development of causal models in this study apply structural equation modeling (SEM) techniques where constructs are specified as

latent variables, each measured by multiple indicators to analyze a measurement model, and the relationships between latent variables are represented by a structural model.

4. Research Methodology

A quantitative research design was conducted and a survey research method was used in this research to test research hypotheses and to answer research questions. A self-administered structured online questionnaire was designed to measure the variables in the proposed theoretical model.

4.1 Measurement development

The research model consists of eight constructs, including management support, perceived self-efficacy, perceived complexity, perceived cost, hedonic value, utilitarian value, perceived risk, and intention to adopt NFRs. The measurement items were adapted from previous studies to ensure the validity of the constructs and further modified to fit the context of NFRs. Management support items were adopted from Premkumar [29] and perceived self-efficacy items were from Li et al. and Pappas et al. [40]. Items for NFR's perceived complexity were new indicators introduced in this study. Items for perceived cost were taken from Carr [41]. Items for hedonic value were taken from Gan & Wang [23]. Items for utilitarian value were from Yang et al. [14], items for perceived risk were adapted from Yu et al. [17], and adoption intention items were from Ozturk [25] and Yang et al. [14]. Each of the indicators is measured on a 5-point Likert scale. The measures are treated as interval scale measures in the analyses with the end points ranging from "strongly disagree", 1, to "strongly agree", 5.

4.2 Data collection

This research selected the software engineers from an international software development company, which primarily provides investment and financial services solutions. Multiple technologies and system development methodologies have been adopted by the selected company. There are specialists in most, if not all, areas of system development working in the company. The online survey was distributed mainly in Thailand and the United Kingdom. The survey received 217 responses. There were 17 outliers (i.e. values 3 or more standard deviations from the mean [42]) among the values of the variables in the theoretical model and the corresponding questionnaires were removed from the sample. This left a final sample of size 200, which is an acceptable sample size in studies where SEM is used [42]. Table 1 shows the demographic information of respondents.

Table 1. Demographic Information of Respondents.

Characteristic	Frequency	Percentage
Age		
below 31	67	33.5%
31-40	85	42.5%
41-50	40	20.0%
above 50	8	4.0%
Work Experience		
< 3 years	39	19.5%
3-6 years	43	21.5%
7-10 years	37	18.5%
11-14 years	35	17.5%
15-18 years	20	10.0%
> 18 years	26	13.0%
Job Position		
Analyst	24	12.0%
Application Support	16	8.0%
Architect	1	0.5%
Developer	58	29.0%
Manager	38	19.0%
System Admin	14	7.0%
Tester	44	22.0%
Other	5	2.5%
Working Location		
Thailand	154	77.0%
United Kingdom	44	22.0%
India	1	0.5%
United States	1	0.5%

Among the 200 respondents, the majority (42.5 percent) are aged between 31 and 40. 59 percent of the respondents have more than 7 years of working experience in IT field. 29 percent of the respondents are developers and 22 percent are testers. The majority work in Thailand (77 percent) and United Kingdom (22 percent).

Independent samples T-tests were used to examine significant differences

between software engineers who have working experience less than 7 years, and 7 years and above. The results showed that software engineers who have less working experience have stronger believe in their self-efficacy to develop NFRs. Software engineers who have more working experience feel that they have less support from management. However, they tend to have stronger believe that NFRs will have utilitarian value to system development. Both groups show strong positive intention to adopt NFRs.

5. Analysis and Results

5.1 Measurement model analysis

A Confirmatory Factor Analysis (CFA) using SEM techniques was done in AMOS 18 to evaluate the association of each item with its specific measurement. For a list of factor loading, see Table 2. The Composite Reliability (CR) indicates the reliability and internal consistency of a latent construct. CR is calculated using the given formula: (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (summation of error variables)}. A minimum value of CR is 0.6 in order to achieve composite reliability for a construct [43]. The Average Variance Extracted (AVE) indicates the average percentage of variation explained by the measuring items for a latent construct. AVE is calculated using the given formula: summation of the square of the factor loadings/number of indicators. The AVE values exceeding 0.5 indicate the reliability of the measurement model in measuring the construct [43]. The analysis indicated that the CR and AVE for each latent construct are above 0.6 and 0.5 respectively, thus confirming reliability and convergent validity (see Table 2).

The fit indices of the measurement model (χ^2=160.433 with DF=107, GFI=0.92, AGFI=0.87, CFI=0.96, TLI=0.95, RMSEA=0.05) exceeded their respective common acceptance levels [43-44], thus demonstrating that the measurement model exhibited a fairly good fit with the data collected.

5.2 Structural model

The proposed hypotheses were tested by analyzing the significance of the relationships between the model variables. Table 4 shows the standardized path coefficients and hypothesis testing results for each of the hypothesized relationships. The fit indices of the theoretical model (χ^2=243.249 with DF=124, GFI=0.89, AGFI=0.84, CFI=0.92, TLI=0.90, RMSEA=0.07) did not all achieve the recommended values suggested [43-44]. Modifications to this model were necessary in order to improve model's fit statistics.

The squared correlations between factors were compared with the AVE of each factor. The squared correlations between factors were lower than the average variance extracted of the individual factors, thus confirming discriminant validity [43] (see Table 3).

It was found that the constructs of perceived complexity and management support do not have significant relationships to software engineer's hedonic value judgments. It appeared that both perceived complexity of the NFRs and management support have significant correlations with software engineer's perceived self-efficacy to work on NFRs. Previous studies also suggested the correlation between perceived complexity and self-efficacy [45-46], as well as the correlation between management support and self-efficacy [47].

Table 2. Convergent Validity and Reliability.

Indicator	Factor Loading	CR	AVE
Management Support (MS)			
MS1: Management has allocated enough resources for adoption of NFRs.	0.832	0.865	0.681
MS2: Management enthusiastically supports the adoption of NFRs.	0.846		
MS3: Management actively encourages employees to apply NFRs in their daily tasks.	0.796		
Perceived Self-Efficacy (SE)			
SE1: I believe I can be proficient in developing NFRs for system development.	0.752	0.864	0.764
SE2: I feel capable of developing NFRs for the system.	0.981		
Perceived Complexity (PX)			
PX1: NFRs are vague and hard to define.	0.854	0.796	0.662
PX2: NFRs are difficult to analyze and test.	0.771		
Perceived Cost (C)			
C1: I believe that the implementation costs associated with NFRs are expensive.	0.831	0.815	0.596
C2: I believe that the tools and technology costs associated with NFRs are expensive.	0.749		
C3: I believe that the support costs associated with NFRs are expensive.	0.732		
Hedonic Value (H)			
H1: Working on NFRs is one that I would feel interested in.	0.917	0.802	0.672
H2: Working on NFRs would make me feel good.	0.710		
Utilitarian Value (U)			
U1: NFRs improve the quality of the work I do.	0.779	0.758	0.611
U2: NFRs enhance the effectiveness of the system development.	0.784		
Perceived Risk (R)			
R1: I think that the adoption of NFRs would lead to financial risk for the system development because of the possibility of high cost and complexity.	0.886	0.695	0.546
R2: Adopting NFRs is risky to system development.	0.554		
Intention to Adopt NFRs (I)			
I1: Given the chance I intend to work on NFRs.	0.732	0.718	0.561
I2: I predict I would work on NFRs in the future.	0.765		

Table 3. Discriminant Validity.

Factor	MS	SE	PX	C	H	U	R	I
MS	**0.681**							
SE	0.035	**0.764**						
PX	0.007	0.043	**0.662**					
C	0.003	0.003	0.266	**0.596**				
H	0.032	0.320	0.031	0.000	**0.672**			
U	0.005	0.201	0.050	0.034	0.305	**0.611**		
R	0.023	0.000	0.320	0.260	0.001	0.045	**0.546**	
I	0.024	0.271	0.023	0.000	0.433	0.263	0.001	**0.561**

Construct Labels: MS = Management Support, **SE** = Perceived Self-Efficacy, **PX** = Perceived Complexity, **C** = Perceived Cost, **H** = Hedonic Value, **U** = Utilitarian Value, **R** = Perceived Risk, **I** = Intention to Adopt NFRs

Note: Average Variance Extracted (AVE) by each construct is on the diagonal.
Squared correlations between constructs is on the off-diagonal.

Table 4. Path Coefficients of the Theoretical Model.

Relationship	Standardized Estimate	S.E.	C.R.	P	Result
H1a: Management Support → Hedonic Value	0.095	0.063	1.331	0.183	Not Support
H1b: Management Support → Perceived Risk	0.107	0.081	1.447	0.148	Not Support
H2a: Perceived Self-Efficacy → Hedonic Value	0.594	0.085	7.483	***	**Support**
H2b: Perceived Self-Efficacy → Utilitarian Value	0.457	0.088	4.858	***	**Support**
H3a: Perceived Complexity → Hedonic Value	-0.081	0.054	-1.109	0.267	Not Support
H3b: Perceived Complexity → Utilitarian Value	-0.169	0.055	-1.978	*	**Support**
H3c: Perceived Complexity → Perceived Risk	0.417	0.083	4.582	***	**Support**
H4: Perceived Cost → Perceived Risk	0.342	0.086	4.384	***	**Support**
H5: Hedonic Value → Intention to Adopt NFRs	0.585	0.086	5.621	***	**Support**
H6: Utilitarian Value → Intention to Adopt NFRs	0.239	0.087	2.607	**	**Support**
H7: Perceived Risk → Intention to Adopt NFRs	0.001	0.052	0.017	0.986	Not Support

Note: *, **, and *** indicate statistical significance at level of 0.05, 0.01, and 0.001 respectively.

It was also found that perceived complexity has significant correlation with perceived cost of NFRs. This also has been mentioned in a previous study [48]. Perceived risk of the NFRs did not have direct significant effect on software engineer's intention to adopt NFRs. However, perceived risk was found to have negative significant correlation with NFRs' perceived utilitarian value. This is supported by previous studies [14, 17] which empirically found a significant relationship with perceived risk toward perceived value. Thus, the final model introduced four new relationships. Perceived complexity negatively affects perceived self-efficacy; management support positively affects perceived self-efficacy; perceived complexity positively affects perceived cost; and perceived risk negatively affects utilitarian value of NFRs.

Upon revising the model by introducing perceived risk as a mediating variable between perceived complexity and utilitarian value, it was found that the direct effect of perceived complexity on utilitarian value has become insignificant. Therefore, the direct relationship between perceived complexity and utilitarian value was removed from the final model. The relationships, perceived complexity and hedonic value, management support and perceived risk, management support and hedonic value, and perceived risk and intention to adopt NFRs were also removed as they were found to be insignificant in the original model. The unstandardized and standardized path coefficients are shown in Table 5.

Table 5. Path Coefficients of the Final Model.

Relationship	Unstandardized Estimate	Standardized Estimate	S.E.	C.R.	P
Management Support → Perceived Self-Efficacy	0.178	0.219	0.065	2.757	**
Perceived Self-Efficacy → Utilitarian Value	0.468	0.475	0.088	5.320	***
Perceived Self-Efficacy → Hedonic Value	0.676	0.620	0.086	7.839	***
Perceived Complexity → Perceived Cost	0.432	0.510	0.077	5.606	***
Perceived Complexity → Perceived Risk	0.383	0.409	0.096	4.000	***
Perceived Complexity → Perceived Self-Efficacy	-0.153	-0.214	0.059	-2.609	**
Perceived Cost → Perceived Risk	0.344	0.311	0.107	3.207	***
Perceived Risk → Utilitarian Value	-0.172	-0.229	0.067	-2.589	**
Utilitarian Value → Intention to Adopt NFRs	0.226	0.249	0.083	2.728	**
Hedonic Value → Intention to Adopt NFRs	0.479	0.583	0.084	5.671	***

Note: *, **, and *** indicate statistical significance at level of 0.05, 0.01, and 0.001 respectively.

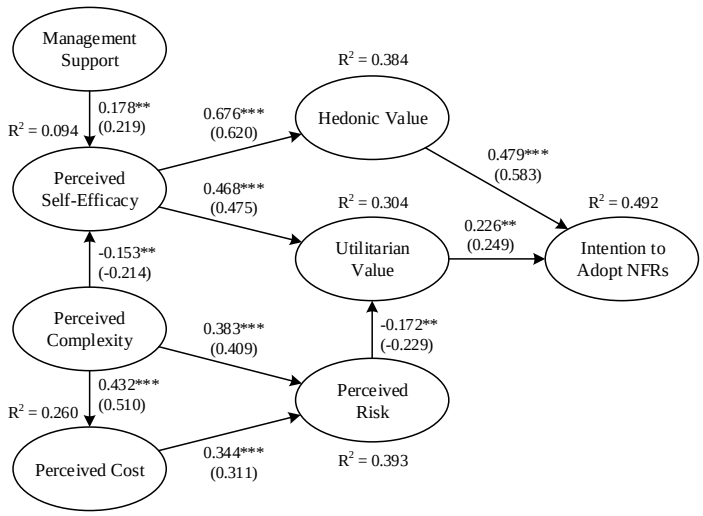
The squared multiple correlations (R^2) of the dimensions in the model, where R^2 is the proportion of the variance of each endogenous variable that is explained by the variables affecting it, explain 49% of the intention to adopt NFRs. All the model-fit indices exceeded their respective common acceptance levels (χ^2=192.37 with DF=125, GFI=0.90, AGFI=0.87, CFI=0.95, TLI=0.94, RMSEA=0.05), and thus exhibited a good model fit [43-44]. The full details of relationships in the final model are displayed in Fig. 2.

6. Discussion

The empirical results of the study showed that both perceived utilitarian value and hedonic value had significant influence on software engineers' intention to adopt NFRs, whereas hedonic value, which is more towards software engineer's personal feeling, had greater impact than NFRs' utilitarian value. The results were consistent with previous studies [22-23, 38]. Therefore, it is crucial to help software engineers completely perceive value of NFRs in order to ensure that they will be happy to work on NFRs when necessary.

Both utilitarian value and hedonic value were impacted by software engineer's

perceived self-efficacy, which was found to have a large total effect on intention to adopt NFRs. This means that the software engineers who believes in their ability to effectively work on NFRs are more likely to be more aware of the usefulness and to feel more comfortable with developing NFRs. The results showed that the greater the complexity of the NFRs perceived by a software engineer, the less they feel confident of their capability to effectively work on NFRs.



Note: The unstandardized path coefficients are shown followed by *, **, or *** if the effect is statistically significant at a level of 0.05, 0.01, or 0.001, respectively. The standardized path coefficients are shown in parentheses.

Fig. 2. Testing Results of the Final Model.

It was also found that management support positively affected perceived self-efficacy. To improve their self-efficacy, it is important that they get enough support from management. This could be done by providing more time and resources for software engineers to explore more about the NFRs, and help them to understand the importance of NFRs in system development. Examples are training sessions, on-the-job training, more encouragement, and knowledge-sharing from the experts.

Perceived risk of NFRs was not found to have significant direct effect on adoption intention. However, after modifying the model, perceived risk was found to have negative significant impact on utilitarian value judgments. The results suggested that software engineers' perception of utilitarian value decreases if they feel that adopting NFRs is risky to system development. The two important factors, which were found to have impact on perceived risk, were the costs associated with NFRs and the complexity of the NFR itself. Both were found to significantly affect perceived risk. Perceived complexity also affected the perception of an NFR's cost, which made perceived complexity have a greater total effect on perceived risk than perceived cost. The relationship between complexity and cost has also been mentioned in other research [48]. Software engineers may believe that NFRs are costly in system development due to their complexities which require time, effort, and specific techniques and tools. It is important to make software engineers understand that the corrections of NFRs are much more difficult and expensive if they were not considered in the early stage of system development. NFRs should be treated as equally important as FRs. They should be well documented with clear explanations and well-specified quantitative measurements. This will reduce

the complexity of NFRs for a software engineer to work on those requirements.

7. Implications

The study has practical implications for managers of system development. Firstly, software engineers' hedonic value judgment was found to have a larger impact on their intention to work on NFRs than utilitarian value judgment. Hedonic value is more subjective and personal than utilitarian value. Software engineers' motivations can be derived from the feeling that NFRs are interesting, challenging, or gratifying to work on. The hedonic experience results in positive moods and higher levels of satisfaction. A hedonic encounter can involve greater engagement with the NFR development process. Nevertheless, utilitarian value also significantly affects adoption intention and must not be discounted. Secondly, software engineers' self-efficacy significantly influences their general minds to adopt NFRs, through utilitarian value and hedonic value. The belief in their own abilities and self-confidence is impacted by the complexity of the tasks and the support from management. Therefore, the managers should get more involved with the process. Finally, because of NFRs' complexity, software engineers tend to think that adopting NFRs is a high cost activity and risky to the system development process, which will impact how they see the usefulness of NFRs. It is important to understand that NFRs are often more critical than individual FRs when evaluating the success or failure of the system [1]. NFRs' complexity could be reduced if they are well-managed and incorporated into different phases of software development process [2]. A project manager should pay more attention to the necessary NFRs and provide sufficient resources to deliver them as part of the project deliverables.

This study also contributes to a theoretical understanding of the factors that promote NFR adoption on the individual level, which extended the theory of perceived value and perceived risk from IT products and services to the software engineering process, whereas little or no research has been conducted to address this problem. This study also investigated the importance of other variables derived from different fields of study that have impacts on an individual's perceived value and perceived risk, which could be applied to the adoption of other system development methodologies and techniques.

8. Limitations and Future Research

This study generalized the term of NFRs and investigated the perceptions of software engineers who were mainly developing financial systems. It is possible that software engineers who develop different types of systems may have different feelings toward NFRs. Future studies should focus on different groups of software engineers who develop the systems in which specific types of NFRs are the critical factors for success of their information system. For instance, a study to examine software engineers' perceptions toward system security and reliability requirements, who develop IT systems for government agencies or investment firms.

9. Conclusion

This paper was conducted with the intention of providing further understanding of the factors that affect software engineers' intentions to adopt NFRs. Four determinant factors (perceived self-efficacy, management support, perceived complexity, and perceived cost) of utilitarian value, hedonic value, and perceived risk were proposed and tested. Empirical data was obtained from 200 software engineers from an international software development company. The data was analyzed using SEM techniques. Modifications to the theoretical model were done in order to improve the model's fit statistics. All causal

paths in the final model were proven to have significant values.

This study found that perceived utilitarian value and hedonic value had significant influence on software engineers' intention to adopt NFRs. Perceived hedonic value had a greater influence on software engineers' intention than the level of NFRs' perceived utilitarian value. Perceived risk of NFRs was not found to have significant direct effect on adoption intention, but it was found to have negative significant impact on utilitarian value judgments. Among the proposed determinants, software engineers' perceived self-efficacy was found to have the largest total effect on intention to adopt NFRs, whereas software engineers' perceived self-efficacy can be affected by the support from management and perceived complexity of NFRs. NFRs' perceived complexity and perceived cost were found to have positive impacts on perceived risk.

This study contributes to a theoretical understanding of the factors that promote NFR adoption on the individual level through perceived value and perceived risk. While utilitarian value, hedonic value, and perceived risk have been generally studied together in the context of IT products and services adoption, this study also examined whether the same concept can be applied in the context of requirements engineering. This study also suggests practical implications for system development managers to motivate software engineers' intention to work on NFRs and be more engaged with the development process.

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References

[1] Thakurta R. A framework for prioritization of quality requirements for inclusion in a software project. Software Quality Journal. 2013;21(4):573-97.

[2] Ullah S, Iqbal M, Khan AM. A survey on issues in non-functional requirements elicitation. International Conference on Computer Networks and Information Technology; 2011.

[3] Eckhardt J, Vogelsang A, Fernández DM. Are "non-functional" requirements really non-functional? Proceedings of the 38th International Conference on Software Engineering - ICSE 16; 2016.

[4] Behutiye W, Karhapää P, Costal D, Oivo M, Franch X. Non-functional requirements documentation in agile software development: Challenges and solution proposal. Product-Focused Software Process Improvement Lecture Notes in Computer Science. 2017;515–22.

[5] Galinec D, Luić L. The impact of application non-functional requirements on enterprise architecture. Proceedings of the 22nd Central European Conference on Information and Intelligent Systems; 2011.

[6] Kaur H, Sharma DA. Non-functional requirements research: survey. International Journal of Science and Engineering Applications. 2014;3(6): 172-82.

[7] Cortesi A, Logozzo F.. Verification of non-functional requirements by abstract interpretation. Handbook of Research on Service-Oriented Systems and Non-Functional Properties. 2012;22-35.

[8] Ameller D, Ayala C, Cabot J, Franch X. How do software architects consider non-functional requirements: An exploratory study. 2012 20th IEEE International Requirements Engineering Conference (RE); 2012.

[9] Vermeulen, D, de Wager M. & Ravesteijn P. Focus on non-functionals! The effect of focusing on non-functional

requirements on the maturity of the requirements engineering process. Communications of the IIMA. 2017;15(1):77-85.

[10] Caracciolo A, Lungu MF, Nierstrasz O. How do software architects specify and validate quality requirements? Software Architecture Lecture Notes in Computer Science. 2014;374-89.

[11] Haigh M. Software quality, non-functional software requirements and IT-business alignment. Software Quality Journal. 2010;18(3):361-85.

[12] Rogers EM. Diffusion of innovations. New York: Free Press; 1983.

[13] Lai KS, Yusof NA, Kamal EM. Innovation orientation in architectural firms. Construction Innovation. 2016;16(4):425–45.

[14] Yang H, Yu J, Zo H, Choi M. User acceptance of wearable devices: An extended perspective of perceived value. Telematics and Informatics. 2016;33(2): 256-69.

[15] Berraies S, Yahia KB, Hannachi M. Identifying the effects of perceived values of mobile banking applications on customers: Comparative study between baby boomers, generation X and generation Y, International Journal of Bank Marketing. 2017;35(6):1018–38.

[16] Zeithaml VA. Consumer perceptions of price, quality, and value: A means-end model and synthesis of evidence. Journal of Marketing. 1988;52(3):2-22.

[17] Yu J, Lee H, Ha I, Zo H. User acceptance of media tablets: An empirical examination of perceived value. Telematics and Informatics. 2017;34(4):206-23.

[18] Purwanto P, Kuswandi K. Effects of flexibility and interactivity on the perceived value of and satisfaction with e-commerce (evidence from Indonesia). Market-Tržište, 29(2). 2017;139-159.

[19] Sánchez-Fernández R, Iniesta-Bonillo MÁ. The concept of perceived value: a systematic review of the research. Marketing Theory. 2007;7(4):427–51.

[20] Hu F, Chuang CC. A study of the relationship between the value perception and loyalty intention toward an e-retailer website. Journal of Internet Banking and Commerce. 2012;17(1):1-18.

[21] Yang K, Lee H. Gender differences in using mobile data services: utilitarian and hedonic value approaches. Journal of Research in Interactive Marketing. 2010;4(2):142-56.

[22] Davis R, Lang B, Gautam N. Modeling Utilitarian-Hedonic Dual Mediation (UHDM) in the purchase and use of games. Internet Research. 2013;23(2): 229-56.

[23] Gan C, Wang W. The influence of perceived value on purchase intention in social commerce context. Internet Research. 2017;27(4):772-85.

[24] Tanadi T, Samadi B, Gharleghi B. The impact of perceived risks and perceived benefits to improve an online intention among Generation-Y in Malaysia. Asian Social Science. 2015;11(26):226-38.

[25] Ozturk AB. Factors affecting individual and organizational RFID technology adoption in the hospitality industry (Doctoral Dissertation). Oklahoma State University, Oklahoma, United States; 2010.

[26] Arshad A, Zafar M, Fatima I, Khan SK. The impact of perceived risk on online buying behavior. International Journal of New Technology and Research (IJNTR). 2015;1(8):13-18.

[27] Awa HO, Ojiabo OU, Orokor LE. Integrated technology-organization-environment (T-O-E) taxonomies for

technology adoption. Journal of Enterprise Information Management. 2017;30(6):893–921.

[28] Naser K, Mosleh F, Basil H. An investigation of factors influencing the adoption of electronic management based on the Theory of Reasoned Action (TRA): A case study in the University of Technology / IRAQ. International Journal of Computer Applications. 2015;123(18): 1-9.

[29] Premkumar G. A meta-analysis of research on information technology implementation in small business. Journal of Organizational Computing and Electronic Commerce. 2003;13(2):91-121.

[30] Kulviwat S, Bruner II GC, Neelankavil, JP. Self-efficacy as an antecedent of cognition and affect in technology acceptance. The Journal of Consumer Marketing. 2014;31(3):190–9.

[31] Wang YS, Wang YM, Lin HH, Tang TI. Determinants of user acceptance of internet banking: an empirical study. International Journal of Service Industry Management. 2003;14(5):501-19.

[32] Pichlak M. The innovation adoption process: a multidimensional approach. Journal of Management and Organization. 2016;22(4):476-94.

[33] Yim R, Castaneda J, Doolen T, Tumer I, Malak R. Functional complexity impact on engineering design project risk indicators. IIE Annual Conference, Proceedings. 2013;979-88.

[34] Guszak I, Pandža I. Concept of perceived value with focus on perceived costs of convenience goods. Proceedings of the 5th International Conference Economic Development Perspectives of SEE Region in the Global Recession Context, ICES2010; 2010.

[35] Zhu G, Sangwan S, Ting-Jie L. A new theoretical framework of technology acceptance and empirical investigation on self-efficacy-based value adoption model. Nankai Business Review International. 2010;1(4): 345-72.

[36] Xu B, Lin Z, Shao B. Factors affecting consumer behaviors in online buy-it-now auctions. Internet Research. 2010;20(5): 509-526.

[37] Hirschman EC, Holbrook MB. Hedonic consumption: emerging concepts, methods, and propositions. Journal of Marketing. 1982;46(3):92-101.

[38] Yu J, Zo H, Choi MK, Ciganek AP. User acceptance of location-based social networking services. Online Information Review. 2013;37(5):711-30.

[39] Babin BJ, Darden WR, Griffin M. Work and/or Fun: Measuring hedonic and utilitarian shopping value. Journal of Consumer Research. 1994;20(4):644-656.

[40] Pappas IO, Pateli AG, Giannakos MN, Chrissikopoulos V. Moderating effects of online shopping experience on customer satisfaction and repurchase intentions. International Journal of Retail & Distribution Management. 2014;42(3): 187-204.

[41] Carr A. An examination of the adoption of RFID technology in healthcare organizations. Organization Development Journal. 2015;33(4):81-102.

[42] Kline, RB. Principles and practice of structural equation modeling (3rd Edition). Guilford Press, London; 2011.

[43] Awang Z. SEM Made Simple: A gentle approach to learning structural equation modelling. MPWS Rich Publication; 2015.

[44] Hair J, Black W, Babin B, Anderson R. Multivariate data analysis (7th Edition). Prentice Hall. London; 2009.

[45] Brown LJ. Determinants of user adoption of policy and procedure software: An examination of relationships between task-specific computer self-efficacy, perceived relevance, perceived complexity and predictions of intent to use information technology (Doctoral Dissertation). Central Michigan University, Michigan, United States; 2012.

[46] Hu J, Huhmann BA, Hyman MR. The Relationship between task complexity and information search: The role of self-efficacy. Psychology and Marketing. 2007;24(3):253–70.

[47] Chi FJ. Role of the user's efficacy expectations in predicting the usage of computer-mediated communication technologies: The case of electronic mail by controlling the effect of management support, system quality and individual previous computer experience (Doctoral Dissertation). Mississippi State University, Mississippi, United States; 1996.

[48] Sivadasan S, Smart J, Calinescu A. Schim J, Fjeldsoe-Nielsen L. The costs of complexity. Manufacturing Engineer. 2000;79(3):109-12.

[49] Sargent K, Hyland P, Sawang S. Factors influencing the adoption of information technology in a construction business. Australasian Journal of Construction Economics and Building. 2012;12(2):72-86.