

Analyzing Differences in Risk Perceptions between Developers and Acquirers in OTS-based Custom Software Projects Using Stakeholder Analysis

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ABSTRACT

Project stakeholders can have different perceptions of risks and how they should be mitigated, but these differences are not always well understood and managed. This general issue occurs in Off-the-shelf (OTS)-based custom software development projects, which use and integrate OTS software in the development of specialized software for an individual customer. We report on a study of risk perceptions for developers and acquirers in OTS-based custom software development projects. The study used an online questionnaire-based survey. We compared stakeholders' perceptions about their level of control over and exposure to 11 shared risks in OTS-based software, in 35 OTS-based software developments and 34 OTS-based software acquisitions of Indonesian background. We found that both stakeholders can best control, and are most impacted by, risks about requirements negotiation. In general stakeholders agree who can best control risks (usually the developer), but there were different perceptions about who is most impacted by risks (the developer reported either themselves or both stakeholders; while usually the acquirer reported both stakeholders). In addition, both stakeholders agree that the acquirer is most impacted by the risk of reduced control of future evolution of the system. We also found disagreement about who is most impacted by the risk of lack of support (usually each stakeholder reported themselves). This paper makes two main contributions. First, the paper presents a method based on stakeholder analysis to compare perceptions of the respondents about which stakeholder is affected by and can control risks. Second, knowing stakeholder agreement on which stakeholder has high risk control should be helpful to rationalize responsibility for risks.

Categories and Subject Descriptors

D.2.9 [Software Engineering]: Management. K.6.1 [Management of Computing and Information Systems]: Project and People Management – *management techniques*.

Keywords: Risks, perception, Off-the-shelf (OTS), developers, acquirers, survey

1. INTRODUCTION

Custom software development is either in-house or contracted software development with specific requirements for an individual

customer [13] [22]. Off-The-Shelf (OTS) software is “a commercially available or open source piece of software that other software projects can reuse and integrate into their own products” [41]. This study focuses on OTS-based custom software development, which uses and integrates OTS software in the development of specialized software for an individual customer [8]. The relationship between acquirers and developers in OTS-based custom software development is depicted in Figure 1.

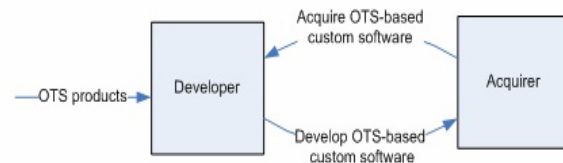


Figure 1. OTS-based custom software project

Risks associated with a software project affect all stakeholders [11] [33] [34] [46]. Here, we defined a risk as a deviation from the expected objective [48]. Risks arise from the start of the software acquisition process [33][34]. Most of the literature focuses on risks from the perspective of the software development organization, and little attention has been given to the software acquirer's perspective [18][33]. This paper covers both perspectives for OTS-based custom software projects.

One approach that accounts for different stakeholder involvement in a project is stakeholder analysis [10] [44] [46]. Stakeholders are defined as anyone who are affected by or can influence the system under development [10] [19] [44] [46]. Stakeholder analysis considers activities and issues such as: stakeholder identification, area of interest, stakeholder contribution and expectation, stakeholder influence, strategy to involve stakeholder and stakeholder responsibility [3] [16]. Responsibility is defined as “a duty, held by some agent, to achieve, maintain or avoid some given state, subject to conformance with organizational, social and cultural norms” [38].

Previous studies have reported that stakeholders tend to perceive the importance of certain risks as higher than others if they cannot control the risks, and also that different stakeholders tend to identify risk from other stakeholders' perspectives [20] [21] [35]. As different stakeholders perceive risk differently [21], therefore there are different perceptions of stakeholder's responsibility for risks. In addition, stakeholder perceptions vary based on either individual's or organization's background, experience, need and expectation [15]. To manage risks effectively, it is important to involve stakeholders [14] [34] aiming to take account differences in risk perceptions and to identify stakeholder responsibility for risks [14].

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This paper focuses on investigating risks shared [34] by developers and acquirers and in particular differences in the perception of risks by the developers and acquirers. Another objective of this paper is to rationalize risk responsibility based on stakeholder analysis. It is expected that risk responsibility is able to provide a methodical and practical consideration to support risk management negotiation through dialogue, deliberation and communication [21]. Therefore this study addresses two research questions as follows, within the context of OTS-based custom software projects.

RQ1: How are OTS-specific risks perceived by developers and acquirers?

RQ2: How should risk responsibilities be defined between developers and acquirers?

Our study of these questions is based on a survey, with survey results analyzed using a new method based on stakeholder analysis [3][10][16][19][44][46].

The remainder of this paper is organized as follows. We first briefly review related work on stakeholder analysis in software development, and then describe our overall research design. We describe our method for analyzing differences in risk perceptions and collected data, before discussing the results and presenting conclusions.

2. STAKEHOLDER ANALYSIS IN SOFTWARE DEVELOPMENT

In software-related projects, stakeholder analysis has been used to identify stakeholders, and to identify their roles, their level of involvement [2][36][44] and their risks [11][23][46]. With regard to software project-related risks, Gotterbarn and Rogerson have developed a software development impact statement comprising a task and associated potential risk that impacts particular stakeholders [11]. The tasks are derived from a work breakdown structure (WBS) of the software project, and might be activities in the WBS or list of requirement specifications [11]. Woolridge et al. [46] has proposed a stakeholder risk assessment during requirements engineering process, comprising stakeholder identification, analyzing stakeholder influence on functional requirements, impact of functional requirements on stakeholders, and assessing and prioritizing stakeholder risks. The Riskit method [23] links risks, project goals and stakeholder to rank risks.

In OTS-based software development, there are studies [7][43] that map OTS-based software development risks to their related stakeholders. However, both software project-related risks and OTS-based software development project risks have not analyzed further differences in risk perceptions among stakeholders. This contrasts with our research which analyzes differences in the perception of risk between developers and acquirers in OTS-based custom software projects.

In the context of development of a socio-technical system, stakeholder responsibility can be modeled using a responsibility model [5][38][39][40]. A responsibility model describes responsibilities within a system under development, agents assigned to these responsibilities and resources used to discharge these responsibilities [38]. In addition, the responsibility should also be assigned to the stakeholder who has competences and capacity needed to discharge the responsibility [39][40].

3. RESEARCH DESIGN

We performed a structured online questionnaire survey to investigate different perceptions of risks of OTS-based software

projects (listed in Table 1) from the developer and acquirer perspectives. We posted the questionnaire online using Google Docs.

3.1 Survey Design

We performed a structured online questionnaire survey based on a prior definition of stakeholders [10][19][44][46] and developed a method based on stakeholder analysis [3][16] to analyze the survey data of differences in OTS-specific risks perceived by software developer and acquirer respondents (illustrated in Figure 2). However, the nature of this study is exploratory and does not test hypotheses.

The questionnaire targeted developers and acquirers of completed OTS-based custom software projects, using convenience sampling to identify potential respondents. Convenience sampling is reasonable to use in an exploratory study [12]. The sample population of the survey was 111 respondents which had a prior academic-industry relationship with the first author. The population consisted of software acquirers contracting OTS-based software to external software developers and software organizations developing OTS-based software for their acquirers of different organizations. The respondents comprised 35 software developers and 34 software acquirers of Indonesian background. We expected to explore differences in risk perceptions as the software developers and acquirers are in different organizations whose backgrounds, experiences, needs and expectations are different [15]. Furthermore, we excluded OTS software producer, who builds OTS software, because we wanted to focus on the software developers and acquirers, who are two key stakeholders in software development projects using and integrating OTS software.

In our survey we asked about risks that should be relevant not only to developers but also to acquirers of OTS-based custom software (described in Table 1). Based on our previous systematic mapping study [25], we focused on selection, integration, and maintenance related risks. As can be seen in Table 1, no studies identified risks to acquirers related to: not being adaptable to requirement changes, requirements not being negotiable, upgrading being unfeasible, lack of information about providers, and lack of support. These risks were nonetheless selected because acquirers may have interactions and contributions to these risks. We used 7 out of 13 of the risks of OTS-based software development reported by Li et al. [27] that acquirers might also control and be impacted by these following risks: selection effort ill-estimated (R1), not adaptable to requirement changes (R2), requirements not negotiable (R3), maintenance planning unfeasible (R7), upgrade unfeasible (R8), lack of information on provider (R9) and lack of support (R10). Respondents were asked who was affected by and who could influence the risks in Table 1. The respondents could choose one out of four options: “developer”, “acquirer”, “both” or “don’t know”.

3.2 Method for analyzing risk perspectives

Here we described our method to analyze the survey data of differences between perceived risks. The method compares perceptions of the respondents about which stakeholder is affected by and can control risks. The method extends the stakeholder analysis approach [3][16], and is illustrated in Figure 2. The method uses a template to compare risk perceptions (summarized in Table 2). As illustrated in Figure 2, the respondents (software developers and acquirers) completed the survey by choosing kind of stakeholder (developer, acquirer, both or don’t know) impacted by and that can control each risk. All respondents’ responses were

mapped to the template (Table 2). Figure 3 models constructs used in the method to analyze the survey.

The method consists of four steps as in the template (in Table 2) and one additional step to rationalize risk responsibility as follows.

- Step 1/“Risks impacting stakeholders” counts the number of each kind of stakeholders affected by investigated risks
- Step 2/“Risks stakeholders can control” counts the number of kind of stakeholder who can control on investigated risks
- Step 3/“Mapping stakeholders from step 1 and 2 into risk control/impact matrix”, maps the number of each kind of stakeholders from step 1 and 2 into a risk control/impact matrix, adapted from power/interest matrix [29][45]. This is illustrated in Figure 4. As this study focused to investigate different risk perceptions between developers and acquirers, the mapping process was only conducted for two kinds of stakeholders from step 1 and 2, developer and acquirer. Therefore if a respondent answering “both” to the survey question then they are included as both a developer and an acquirer. The mapping process is performed separately for developer and acquirer respondents.

In order to map the number of each kind of stakeholder (developer and acquirer) from step 1 and 2 into the risk control/impact matrix for each group of stakeholder respondents, a center point coordinate of the matrix has first to be defined for each risk under investigation.

A center point coordinate is an intersection point between centers of a horizontal (risk impact) and vertical (risk control) dimension of a risk control/impact matrix (as can be seen in Figure 4). The center of horizontal point is half of the number of respondents answering step 1 (risk impact). The center of vertical point is half of the number of respondents answering step 2 (risk control). The center point coordinate has a variable value depending on the number of respondents answering step 1 and 2. The following example demonstrates the mapping process of the developer respondents’ risk perception about themselves. For example, for the risk of not being adaptable to requirement changes (R2) in Figure 5, the total number of developer respondents answering step 1 is 34 and step 2 is 35. Hence, the center point coordinate of the risk control/ impact matrix is (17, 17.5). The number of the developer respondents answering themselves impacted by (step 1) and can control (step 2) risk is 13 and 20 respectively. Furthermore the number of the developer respondents answering both stakeholders impacted by (step 1) and can control (step 2) risk is 20 and 11 respectively. Therefore, the total number of the developer respondents (the sum of both stakeholders and developer) perceive themselves impacted by risk is 33 and can control risk is 31. So for the risk of not being adaptable to requirement changes (R2), developers’ perceptions on themselves can be mapped into high risk impact and control (Key Player (D)).

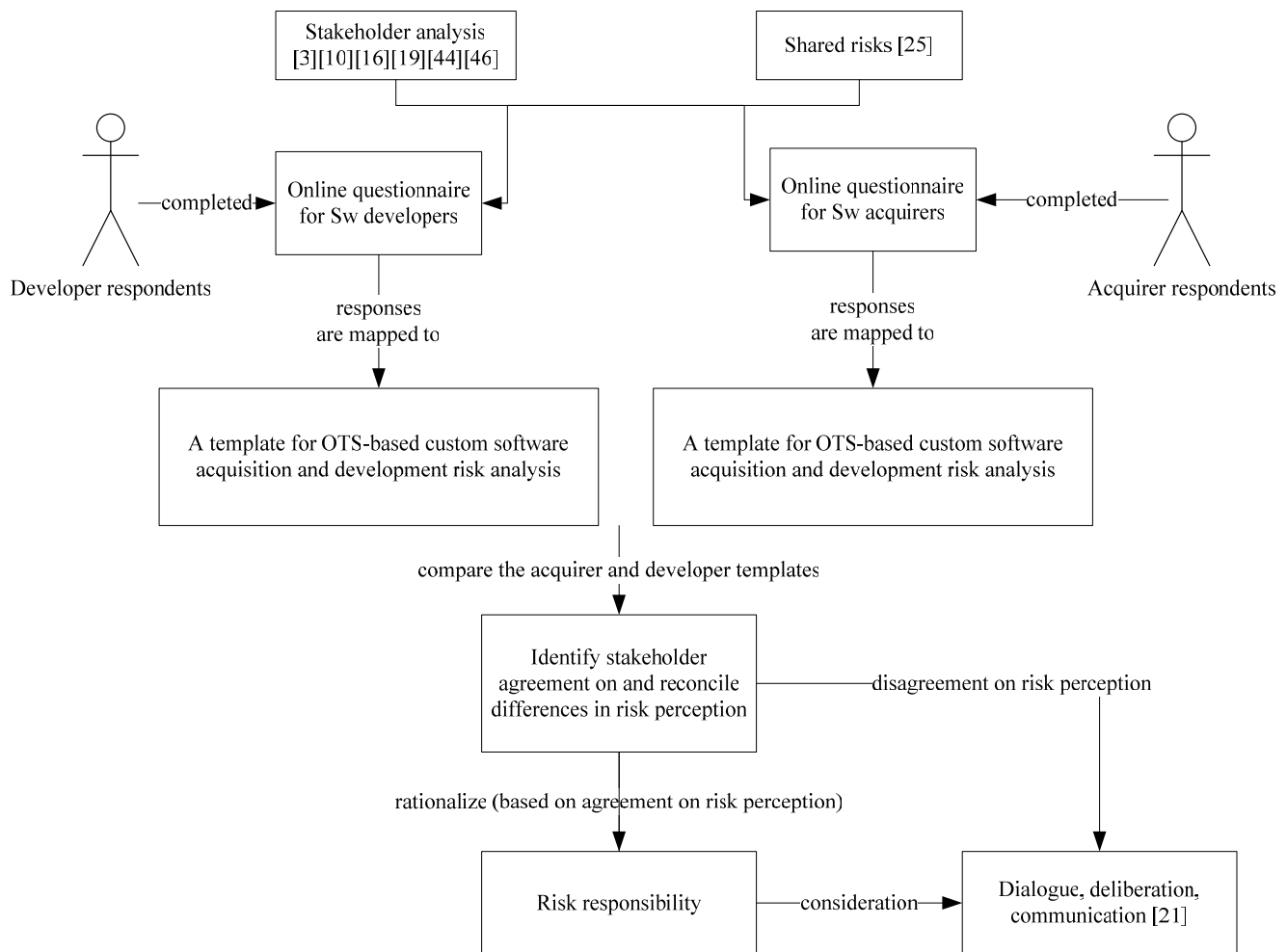


Figure 2. A method for analyzing differences in off-the-shelf risks between the developer and acquirer used in the survey

Table 1. OTS-specific project risks relevant to the developer and acquirer respondents

Stage	Risk		Perspective	
	ID	Item	Dev	Acq
Selection and integration	R1	Selection effort ill-estimated	[31][6] [26][27]	[47]
	R2	Not adaptable to requirement changes	[27]	
	R3	Requirements not negotiable	[26][27] [32]	
	R4	Complicated multi OTS components arrangement	[24][43]	[43][47]
	R5	Insufficient OTS component documents	[28][1]	[47]
	R6	Lack of OTS-driven requirements engineering process	[24][43]	[43][47]
Maintenance	R7	Maintenance planning unfeasible	[26][27]	[47]
	R8	Upgrade unfeasible	[24][26] [27]	
	R9	Lack of information on provider	[26][27] [32]	
	R10	Lack of support	[6][32] [26][27]	
	R11	Reduced control of future evolution of the system	[42]	[43][47]

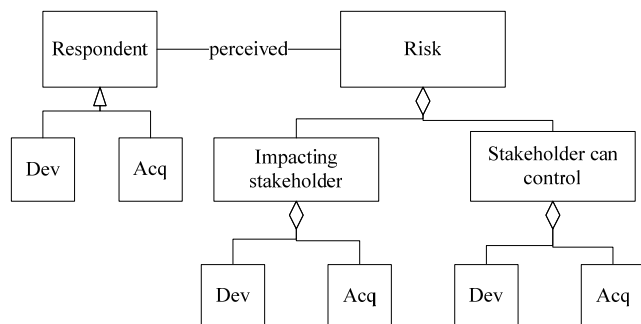


Figure 3. Relationship model of respondent, risk, risk control and impact to stakeholder

Table 2. A template to compare risk perceptions of OTS-based custom software acquisition and development

		Stakeholder	Risks			
			R1	R2	...	R11
Step 1	Risks impacting stakeholders	Developer				
		Acquirer				
		Both				
		Don't know				
Step 2	Risks stakeholder can control	Developer				
		Acquirer				
		Both				
		Don't know				
Step 3	Mapping stakeholders from step 1 and 2 into risk control/impact matrix (see Figure 4)	Developer				
		Acquirer				
Step 4	Comparing risks using the risk control/impact matrix					

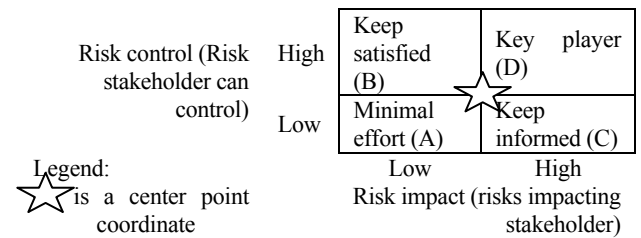


Figure 4. Risk control/impact matrix, adapted from power/interest matrix [29][45]

- Step 4/“Comparing risks using the risk control/impact matrix” compares mapped risk control/impact matrix result between kind of stakeholders in Table 2, developer and acquirer. This comparison is performed separately for the developer and acquirer respondents. For example, as can be seen in Table 3, the risk of reduced control of future evolution of the system (R11) of the developer respondents has developer mapped into Key player (D) and acquirer mapped into Keep informed (C). Here, mapped risk control/impact matrix results of kind of stakeholders (developer and acquirer) are compared (D:C). The comparison result shows that developer respondents perceive themselves to have more control over the risk than their acquirers. Furthermore, the developer respondents perceive that both stakeholders (themselves and their acquirers) are equally impacted (high) by risk.
- Step 5/“Identify stakeholder agreement on and reconcile differences in risk perceptions between developer and acquirer respondents”. This step aims to rationalize risk responsibility to mitigate risks based on stakeholder agreement of which stakeholder has high risk control. Stakeholder who has high risk control can be considered to be responsible on the risk as to

mitigate a risk as high influence [4][37] is needed to control key decisions and task implementation. Moreover, the consideration becomes stronger if both stakeholders also agree on high risk impact.

After the responses of developer and acquirer respondents are mapped to and compared using the template (as can be seen in Figure 2), the completed templates of the developer and acquirer respondents are then compared to identify stakeholder agreement on risk perceptions between developer and acquirer respondents. If there any differences in risk perceptions between the developer and acquirer respondents, stakeholder agreement will be decided from partial agreement between both stakeholder perceptions. In the following examples, reconciliations of different risk perceptions are demonstrated. In addition to the previous example, the acquirer respondents in Table 3 perceive the risk of reduced control of future evolution of the system (R11) mapping developer into Keep satisfied (B) and acquirer into Keep informed (D). Therefore, to identify stakeholder agreement of which stakeholder has high risk control, risk perceptions of the developer and acquirer respondents mapped into the risk control/impact matrix are compared (D:C for the developer respondents and B:D for the acquirer respondents). From this comparison, the developer respondents perceived themselves to have higher risk control compared to their acquirers; the acquirer respondents perceived both stakeholders to have high risk control. To reconcile this difference can be decided that the developers (as indicated in Part 2 Table 3) can best control the risk of reduced control of future evolution of the system (R11). Therefore it can be concluded that both developer and acquirer respondents agree the developer to have high risk control on the risk of reduced control of future evolution of the system (R11). This agreement might be used as a rationale to assign risk responsibility to the developer. In addition, the same procedure is then used to reconcile different risk impact perceptions between the developer (both stakeholders are most impacted by risk R11) and acquirer (the acquirer is most impacted by risk R11) respondents. The reconciliation indicates that both respondents agree that the acquirer has high risk impact compared to the developer; hence the acquirer is the stakeholder most impacted by this risk. Having known stakeholder agreement of which stakeholder has high risk control can be used to rationalize a consideration of risk responsibility in analyzing the different risk perceptions [21].

All of the previous steps are applied and completed for all risks in Table 1.

4. COLLECTED DATA

Of the 111 respondents invited by e-mail, 69 (62%) completed the survey. The respondents were 35 software developers and 34 software acquirers of Indonesian background. The questionnaire collected information about risks of completed OTS-based custom software projects from the developer and acquirer perspectives.

The developers' completed projects were in various domains: IT sector (15), banking or finance (8), public sector (8), e-commerce (3) and ERP (1). Of 35 completed projects, there were 2 different software developer companies that each participated in 2 different projects. All the developer respondents came from well-establish companies, i.e.: 8 multi-national software developing companies, 1 service provider and the remainder from medium and large software development companies. From 35 respondents, only one respondent came from a small company. The mean number of permanent software developers in the projects is 7 and median is 4. The mean

number of part-time software developers involved in the projects is 4 and the median is 3. The developer respondents had positions in the completed OTS-based custom software projects as project manager (13), developer (12), as project manager and software architect (3), software architect (3), as project manager, software architect and developer (2), as project manager and developer (1) and as software architect and developer (1). Only 1 developer respondent did not indicate his/her position. The respondents' level of education varied from 1 certificate, 26 bachelors (1 non computer science) and 8 master (1 non computer science) degrees in computer science.

The software acquirer respondents came from telecommunications (11), government (8), banking (3), automotive industry (3), university (3), plantation (1), insurance (1), private investment joint venture (1), engineering consultant (1), oil and gas (1), and energy company (1). From the telecommunications, automotive industry and university domains, we gathered more than 1 respondent working in different completed projects. The respondents representing the acquirers had positions in the completed OTS-based custom software projects as project manager (8), system analyst (5), user representation (5), IT architect (3), developer (3), IT staff (2), domain expert (2), client team leader (1) and project steering committee (1). Only 4 acquirer respondents did not describe their positions in the projects. The respondents' education consisted of 1 diploma, 23 bachelors (1 non computer science) and 10 master (2 non computer science) degree in computer science.

5. RESULTS

This section presents results of the survey organized by the developed method. Figure 5 and 6 present the questionnaire results mapped to step 1 and 2 of the method template (see Table 2). The results are organized as comparisons of the mapped risk control/impact matrix result between kinds of stakeholder (developer:acquirer) separately for each survey respondents (the developer and acquirer respondents) in Part 1 Table 3. Part 1 Table 3 follows step 4 in the method template (Table 2). Part 2 Table 3 shows stakeholder agreement on risk control and impact, and risk responsibility following step 5 in the developed method. Table 4 summarizes patterns of the comparisons from Part 1 Table 3.

It can be seen from Table 3 and 4, almost all the developer respondents perceive themselves to have higher risk control compared to their acquirers. The data in Table 4 show that for the developer respondents, there are 3 groups of comparison of risk mapped into the risk control/impact matrix. The first is D:D, which in Table 3 is the risk of requirements not negotiable (R3), the developer respondents perceive themselves and their acquirers to have the same high risk control and impact. For the second group, the developer respondents perceive themselves to have higher risk control compared to their acquirers, but perceive themselves to have equal risk impact as their acquirers (D:C in Table 3 and 4). Risks in this group are selection effort ill-estimated (R1), not adaptable to requirement changes (R2), complicated multi OTS components arrangement (R4), and maintenance planning unfeasible (R7) and reduced control of future evolution of the system (R11). The last group, the developer respondents perceive themselves to have higher risk control and impact compared to their acquirers (D:A in Table 3 and 4) as follows: insufficient OTS component documents (R5), lack of OTS-driven requirements engineering process (R6), upgrade unfeasible (R8), lack of information on provider (R9) and lack of support (R10).



Figure 5. The developer respondents' responses mapped to step 1 and 2 of the template (35 respondents)

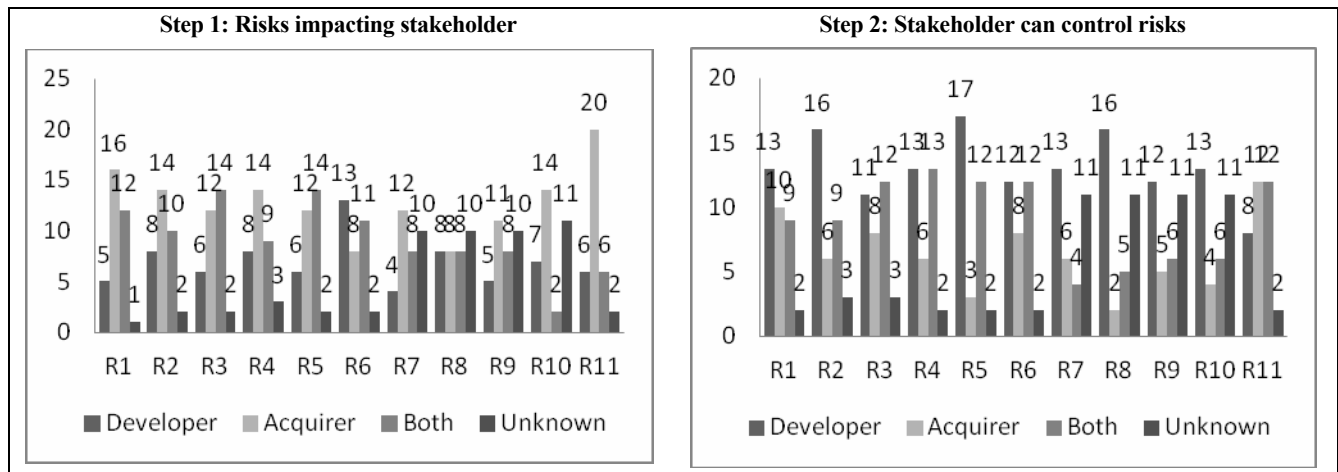


Figure 6. The acquirer respondents' responses mapped to step 1 and 2 of the template (34 respondents)

Table 3. Analyzing of different risk perceptions

Part 1											
Comparison of risk mapped into the risk control/impact matrix (developer:acquirer) from respondent perspectives											
Respondents	Risk (developer:acquirer)										
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
Developer	D:C	D:C	D:D	D:C	D:A	D:A	D:C	D:A	D:A	D:A	D:C
Acquirer	D:D	D:C	D:D	D:D	D:C	D:D	D:C	D:C	D:C	B:C	B:D
Part 2											
Stakeholder agreement on risk control and impact, and risk responsibility											
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11
Stakeholder agreement on risk control	Dev	Dev	Both	Dev	Dev	Dev	Dev	Dev	Dev	Dev	Dev
Stakeholder agreement on risk impact	Both	Both	Both	Both	Dev	Dev	Both	Dev	Dev	-	Acq
Risk responsibility	Dev	Dev	Both	Dev	Dev	Dev	Dev	Dev	Dev	Dev	Dev

Table 4. Summary of comparison of risks mapped into the risk control/impact matrix between the developer and acquirer respondents (summarized from Table 3)

		Patterns of comparison of risk mapped into the risk control/impact matrix (developer:acquirer) from respondent perspectives				
		D:D	D:C	D:A	B:C	B:D
Respondent perspective	Developer	1	5	5		
	Acquirer	4	5		1	1

In Table 4, the acquirer respondents perceive 4 different comparison of risk mapped into the risk control/impact matrix. The first group comparison, the acquirer respondents perceive the following risks high in control and impact for themselves and their developers (D:D): selection effort ill-estimated (R1), requirements not negotiable (R3), complicated multi OTS components arrangement (R4) and lack of OTS-driven requirements (R6). In the second group, the acquirer respondents tend to report higher perceived risk control of the following risks to their developers, but the acquirer respondents tend to report higher perceived risk impact to both themselves and their developers (D:C): not adaptable to requirement changes (R2), insufficient OTS component documents (R5), maintenance planning unfeasible (R7), upgrade unfeasible (R8) and lack of information on provider (R9). In the third group, the acquirer respondents perceive themselves to have higher risk impact but lower risk control compared to their developers (B:C) on the risk of lack of support (R11). Finally, the acquirer respondents perceive themselves to have higher risk impact but equal risk control compared to their developer (B:D) for the risk of reduced control of future evolution of the system (R11).

Part 2 Table 3 shows stakeholder agreements on risk control and impact, including reconciliation results of different risk perceptions between the developer and acquirer respondents on the risks of R1, R4, R5, R6, R8, R9, and R11. With regard to risks R1, R4, R6 and R11, the developer respondents perceived themselves to have higher risk control compared to their acquirers and the acquirer respondents perceived both stakeholders to have high risk control and impact (for R1, R4 and R6) and to have high risk control (for R11). The differences between both stakeholders can be reconciled by agreeing the developer as a stakeholder who has risk control. For the risk of R5, R6, R8 and R9, the developer respondents perceived only themselves as most impacted by these risks (D:A in developer respondents row in Part 1 Table 3), and the acquirer respondents perceived both stakeholders as most impacted by these risks (developer and acquirer of the mapped risk control/impact matrix is either C or D in Part 1 Table 3). To reconcile these differences, it could be decided that the developers are most impacted by these risks (presented in Part 2 Table 3) as the developers always perceived to have high risk impact in these risks by both stakeholders. For risk R11, both stakeholders agree that the acquirer is most impacted by the risk (reduced control of future evolution of the system). This agreement is a reconciliation result of different risk perceptions between the developer (both stakeholders are most impacted by risk R11) and acquirer (the acquirer is most impacted by risk R11) respondents. For the risk of lack of support (R10), this study has found disagreement about who is most impacted by the risk (in R10 in Part 1 Table 3, the developer respondents perceive themselves have higher risk control and impact compared to their acquirer (D:A), while the acquirer respondents perceive themselves have higher risk impact compared to their developers (B:C)).

6. DISCUSSION

6.1 RQ1: How are OTS-specific risks perceived by the developer and acquirer?

Although a previous study has investigated different and common IT project risks as perceived by users and project managers [21], these risks are not specific to OTS-based custom software projects. Our study focused on OTS-specific project risks shared [34] by the developer and acquirer (listed in Table 1). In this section, we use Table 3 to compare risk perceptions mapped into the risk control/impact matrix between the developer and acquirer respondents. This comparison focused on risk control and impact perceived by the developer and acquirer respondents.

As indicated in Part 2 of Table 3, almost all stakeholders agree that the developer can best control risks (in Part 1 Table 3, all developer and acquirer respondents perceive that the developer has high risk control, and the mapped risk control/impact matrix is either D or B). There is only one risk, R3 (requirement not negotiable), where both stakeholders each claim to best control this risk (both respondents perceive high risk control and impact in the mapped risk control/impact matrix).

The developer respondents have two different groups of perceptions about which stakeholder is most impacted by risks. In the first group, developer respondents perceive both stakeholders as most impacted by risks (as shown in Part 1 Table 3, the risks of R1, R2, R3, R4, R7 and R11 whose developer and acquirer of the mapped risk control/impact matrix have high risk impact). In the second group, developer respondents perceive themselves as most impacted by risks (as shown in Part 1 Table 3, the risks of R5, R6, R8, R9 and R10 whose developer and acquirer of the mapped risk control/impact matrix has high and low risk impact, respectively).

The acquirer respondents perceive both stakeholders are most impacted by risks (developer and acquirer of the mapped risk control/impact matrix has high risk impact), except for their developers in R10 and R11. In regard to risk of lack of support (R10) and reduced control of future evolution of the system (R11), the acquirer respondents perceive themselves to have higher risk impact than their developers.

Comparing the developer and acquirer respondents' perspectives about which stakeholders are most impacted by risks, it could be concluded that for the risks of R1, R2, R4 and R7, both stakeholders agree (can be found in Part 2 Table 3) that they both are most impacted by the risks. For the risks of R5, R6, R8 and R9, there are different risk perceptions between the developer and acquirer respondents. From the results section, it is shown that the developers are most impacted by these risks (see Part 2 of Table 3). For the risk of lack of support (R10), this study has found disagreement about who is most impacted by the risk (Part 2 of Table 3). With regard to the risk of reduced control of future

evolution of the system (R11), both stakeholders agree that the acquirer is most impacted by the risk of reduced control of future evolution of the system. The developed method provided a methodical and practical solution that support previous study [21] to analyze differences in the context of the risks of OTS-based custom software projects perceived by the developers and acquirers.

6.2 RQ2: How to define risk responsibility between the developers and acquirers?

As can be seen in Table 3, for only 3 out of 11 risks investigated, (R2, R3, R7) do both the developers and acquirers have exact risk comparison perceptions. It is interesting to analyze differences in the risks perceived by the developers and acquirers.

Understanding of differences in stakeholder perceptions about which stakeholder has high risk control is helpful to rationalize risk responsibility. High influence is needed to control key decisions and task implementation [4][37] to mitigate risks. This study provided a structured method to compare risk control and impact to identify stakeholder agreement on and reconcile differences in risk perceptions between developer and acquirer respondents. The outcomes of the method are risk responsibilities used to rationalize considerations to analyze different risk perceptions through dialogue, deliberation and communication [21]. Furthermore, this study indicated that the developed method supports responsibility models [5][38] [39][40] in rationalizing which stakeholder has responsibility. Having known the responsibility could eventually lead to the identification of roles [5][38] [39][40] to mitigate risks.

As shown in Part 2 Table 3, in all risks except requirements not negotiable (R3), both stakeholders agree that the developer is considered to be responsible on the risks. However, although the acquirer is not considered to be responsible on the risks, to better manage risk mitigation, the developer should inform, consult and involve the acquirer because the acquirer is also impacted (shown in Table 3, in some cases highly impacted) by the risks [29]. Furthermore, for the risk of requirements not negotiable (R3), both stakeholders should collaborate to discharge the responsibility [39] of risk mitigation. In the case of there is no stakeholder agreement on high risk control; the developed method cannot provide a consideration to analyze different risk perceptions (illustrated by Figure 2).

7. THREATS TO VALIDITY

We discuss construct, internal and external validity for the survey.

7.1 Construct validity

Construct validity is about the use of adequate definitions and measures of variables [9]. To prevent construct validity problems, we derived the questionnaire question from stakeholder definition [10] [19] [44][46]. We also used 7 risks from the previous empirical study [27] and 4 additional risks from the literature (can be seen in Table 1). The questionnaire used in this study was reviewed by 3 internal experts and pre-tested using a paper version by 6 industrial respondents.

7.2 Internal validity

Internal validity is concerned with whether research procedures, treatments or experiences of the research participants influence the researcher's ability to draw correct inferences from the data [9]. Providing related information on the beginning of the questionnaire is expected to give background and context information for the

respondents. In addition, this information may act as an initial filter to ensure that the respondents have needed knowledge and want to share his/her experience. There were less than 10 respondent inquiries before and after completing the questionnaire to ensure their understanding on the questionnaire questions. Furthermore, computer science educational backgrounds of almost all of the respondents increase confidence of this study for the respondents in understanding the survey questions.

7.3 External validity

External validity refers to the generalizability from this study [9]. This survey study did not have a big sample size and was only conducted in Indonesia; therefore it may not represent risks of OTS-based custom software development and acquisition in general. There were total 69 respondents, 35 representing software developers and 34 representing software acquirers. The respondents in the sample vary in organization sizes and acquirer/customer domains, which may reduce threats to external validity.

8. CONCLUSION

This study attempted to analyze differences in shared risks [34] of OTS-based custom software projects by comparing risk control and impact of two main stakeholders, the developers and acquirers. We performed an online questionnaire-based survey about OTS-based custom software project risks on Indonesian software developers and acquirers. To analyze the survey results, we developed and applied a method for analyzing differences in OTS-specific risks perceived by the developers and acquirers, based on stakeholder analysis [3][10] [16][19] [44][46].

This study has shown that both stakeholders can best control, and are most impacted by, risks about requirements negotiation. Developer respondents perceived themselves to best control risks, but perceived either themselves or both stakeholders to be most impacted by risks. Acquirer respondents agreed that their developers can best control risks, but perceived both stakeholders as most impacted by risks, except for risks of R10 and R11. For the risk of lack of support (R10), there was disagreement about who is most impacted by the risk (usually each stakeholder reported themselves). With regard to the risk of reduced control of future evolution of the system (R11), both stakeholders agreed that the acquirer is most impacted by the risk of reduced control of future evolution of the system.

The comparison method was developed to analyze the survey results. We use the method to rationalize a default position about which stakeholder should be responsible for risks based on stakeholders' agreement about which stakeholders have high control of each risk [4] [37]. In the context of a specific project, the method may be able to provide an explicit recognition of different risk perceptions, to inform risk management negotiation through dialogue, deliberation and communication [21]. The method can help stakeholders reduce gut feeling judgments and ensure that the risk mitigation decisions can be more objectively reviewed [17]. The results show that responsibility for all risks (except requirements not negotiable) can be rationalized to be the responsibility of the developer. With regard to requirements not negotiable, we rationalized both stakeholders had responsibility of risk.

Even though we did not investigate actual risks from the developer and acquirer perspectives, a study of risk perception is an important approach to understand differences of actual risks between the developers and acquirers. The relationship between perceived and actual risk might be explained by adopting marketing concept [30].

Parasuraman et al. [30] reviewed marketing literature and found "service quality perceptions result from a comparison of consumer expectations with actual service performance" (p. 42). In our future work, we plan to improve the above method for analyzing differences in off-the-shelf risks by including differences of actual risks between the developers and acquirers and assigning level of risk impact and control (low/high) to rank risks through case studies. In addition, as our study based on stakeholder analysis, therefore further investigation on other related factor influencing risk responsibility is strongly recommended.

Overall, the developed method in this study added substantially to our understanding to provide a method-based consideration to analyze different risk perceptions [21]. The method used in this study may be able to be applied to other kinds of projects, to analyze differences in risk perceived by various stakeholders.

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