

## A decision tree approach based on BOCR for minimizing criteria in requirements prioritization

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### ABSTRACT

The requirements selection in the development of a software mostly requires a set of criteria. Determining the criteria used is often confusing because of the many criteria that must match with the characteristics of the project. This study introduces how to classify criteria based on benefits, opportunities, costs, risks (BOCR) to make the requirements prioritization process scalable. Project context characteristics and stakeholder perspectives are essential points discussed in this study because they are crucial in the requirements prioritization process. The criteria obtained from the literature review were followed by a survey to determine the importance of the criteria and their grouping in the BOCR using the decision tree method. There are 38 criteria and are grouped into four categories. There are two very significant criteria with a high level of importance, namely business value and stakeholder satisfaction. A decision tree based on BOCR can be used to classify the criteria for requirements prioritization. This research contributes to assisting software developers in finding and determining the criteria operated during the prioritization of requirements. Additionally, it is important to consider the project context and the collaboration the client and developer when prioritizing requirements.

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## 1. INTRODUCTION

Decision-making by stakeholders in the process of selecting software requirements aims to meet the need itself [1]. The purpose of developing software leads to increased stakeholder satisfaction, according to the characteristics of the context of the software being made. The requirements prioritization process becomes a crucial aspect of the software development life cycle as it ensures the inclusion of all necessary functions in the built software [2]. The criteria used in this process serve as a reference for calculating the prioritization [3]. Many papers include criteria in the calculation process to determine the priority needs [4]. The requirements prioritization technique mostly increases the value that impacts business success. Until now, numerous techniques have overlooked significant factors that substantially impact requirements prioritization, including cost, value, risk, time to market, the number of requirements, and the influence of non-functional requirements on functional requirements [5], [6]. It is crucial to establish criteria that can estimate the importance of each requirement based on the selected factors [7]. The abundance of criteria found in different literature sources greatly affects scalability. Furthermore, a particular factor, the project context, significantly influences the prioritization criteria. The project context plays a crucial role in shaping the specific initiation of the decision-making process, including the participants involved and the criteria used for decision-making [8]. There are

many criteria in literature advancing the categorization of criteria. However, how to classify criteria has not been discussed in depth. This study proposes a grouping of criteria by considering the project context related to the software's requirements.

A widely recognized aspect of requirements prioritization is the utilization of the cost-value approach pioneered by Karlson and Ryan [9]. This approach incorporates the analytic hierarchy process (AHP) to evaluate and compare their relative value and cost requirements. On the other hand, wieger's method emphasizes key factors such as benefit, penalty, cost, and risk as the primary influencers in the decision-making process. To calculate priority, weiger's Method uses the formula:  $\text{priority} = (\text{value}\%) [(\text{cost}\% * \text{cost\_weight}) + (\text{risk}\% * \text{risk\_weight})]$ , where the value in the formula is obtained by adding up the relative benefits and penalties [10]. Moreover, the criteria used in requirements prioritization are undergoing constant evolution. A notable instance is a study conducted by Amiri and Golozari [11], where they introduced a decision-making algorithm that utilizes fuzzy TOPSIS. This algorithm incorporates the time factor and considers criteria such as cost, risk, and quality [11]. Riegel and Doerr thoroughly examined the criteria operated in requirements prioritization through a systematic literature review. The outcomes revealed six primary categories: benefits, costs, risks, penalties and penalty avoidance, business context, and technical context and requirements characteristic [12], where each category has subcategories accompanied by examples of each. Asghar *et al.* [5] presented a hybrid model for requirements prioritization that combines human decision-making with a critical analysis of factors (sub-characteristics) within the scrum development process. MosCoW was used in the study of Asghar *et al.* [5] to filter requirements by including cost, value, risk, time to market, and effort-required factors. Research by Olaronke *et al.* [13] found different aspects or dimensions used to prioritize requirements: importance, time, risk, cost, value, penalty, and precedence. Hujainah *et al.* [14] study exhibited 48 criteria utilized in the requirements prioritization process, along with their frequency of usage. The criteria most commonly employed include the significance of requirements implementation, cost, business value, value, dependency, risk, benefit, effort, penalty, software goals, business goals, completeness, modifiability, performance, schedule, and time [14].

From previous research, many criteria can be used in the process of requirements prioritization. However, grouping criteria becomes a problem that must be solved for requirements prioritization. Up to knowledge in minimizing the number of criteria used in prioritizing the requirements, researchers have yet to maximize the potential of benefits, opportunities, costs and risks (BOCR) as the only criteria considered in prioritization calculation. This study presents steps to grouping criteria based on BOCR involving client-developer by considering project context characteristics. Most problems in calculating requirements prioritization are scalability, time consumption and accuracy [13], [15]–[18]. The process of ranking is usually done by weighting the requirements based on the predetermined criteria. The use of criteria must be appropriate and comply with the characteristics of the project. The impact of stakeholder perspective on the criteria utilized in the requirements prioritization process is a crucial factor that should be considered. When formulating the technique for requirements prioritization, it is imperative to consider the interconnected elements. The requirements criteria, stakeholder elements, process, and implementation are interrelated [4]. The motivation of this research comes from the reasons above, which is to classify criteria in requirements prioritization by involving the client-developer and considering project context characteristics. The search for any criteria used in requirements prioritization has been investigated in the literature and has generated 38 criteria. In the literature study, most of the time, there is no detailed explanation regarding the reasons for selecting criteria. In addition, the requirements prioritization process often encounters many criteria and causes scalability problems. The research motivates for requirements prioritization process to become scalable by grouping the right criteria. Based on the above background, this study tries to clarify the selection of criteria to be used in the prioritization process. These results are intended to help: (i) mapping out what criteria used in requirements prioritization; (ii) describing the correlation coefficient criteria; (iii) categorizing criteria based on BOCR; (iv) explaining the effect of project context characteristics; and (v) defining the influence of the stakeholder perspective in assigning weighting requirements prioritization. The remaining sections of the paper are structured as follows. Section 1 is the introduction. The section 2 presents the method. Section 3 deals with the results and discussion of the paper and survey. The conclusion is presented in section four.

## 2. METHOD

The research method in classifying requirements prioritization criteria is based on literature reviews and surveys. The followings are the steps in this research see in Figure 1:

- Searching for criteria used in papers that discuss requirements prioritization.
- Conducting a survey to determine the level of influence of the 10 most frequently used criteria in the literature associated with requirements prioritization. The survey includes 44 participants who possess software development experience ranging from 6 to 10 years.

- Conducting surveys and interviews with 9 experts to classify the criteria in the BOCR by using the decision tree method. Experts here are people who are specifically involved in software development with more than 6 years of experience.
- Looking for the characteristics of the project context that affect the requirements selection through a literature study.
- Defining previous research to establish the significance of stakeholder perspective in the requirements prioritization process.

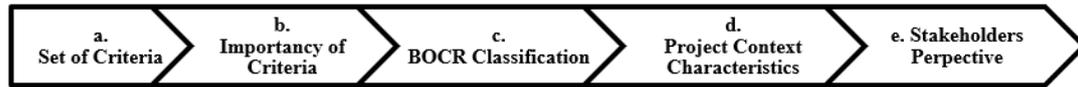


Figure 1. The main five steps

### 3. RESULTS AND DISCUSSION

The initial phase involves identifying the criteria employed in the requirements prioritization process. An examination of papers published in 2010 and 2019 revealed that 38 criteria were utilized in requirements prioritization [19]. Figure 2 illustrates the criteria and the corresponding number of papers in their requirements prioritization [12], [17], [20]–[26].

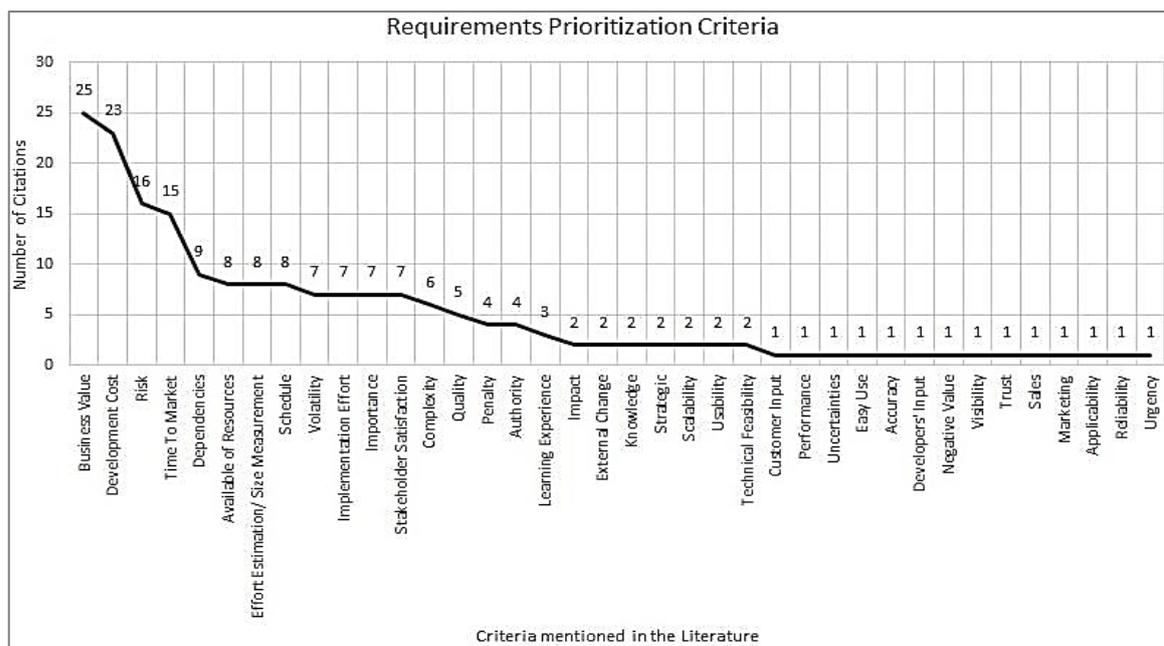


Figure 2. The usage frequency of requirements prioritization criteria

The subsequent phase involves surveying the criteria utilized in the requirements prioritization process. In this survey, the top 10 criteria with the highest frequency were selected: business value, development cost, risk, time to market, dependencies, effort estimation/size measurement, schedule, volatility, implementation effort, and stakeholder satisfaction. Figure 3 provides an overview of the respondent demographics, consisting of 44 participants.

The data of respondents' demographics, 33 (75%) are developers' perspective, with 19 (43%) working as a development team member (Architect/Developer/QA/Tester/UI or UX Designer). For working experience, 17 respondents (39%) are 6 and 10 years of experience, and 12 respondents (27%) are 3 and 5 years of experience. 19 respondents (43%) work in organizations which employ 100 people or above, whereas 16 respondents (36%) work in organizations which employ 10 people or less. Most of the project development frameworks use Agile 26 (59%).

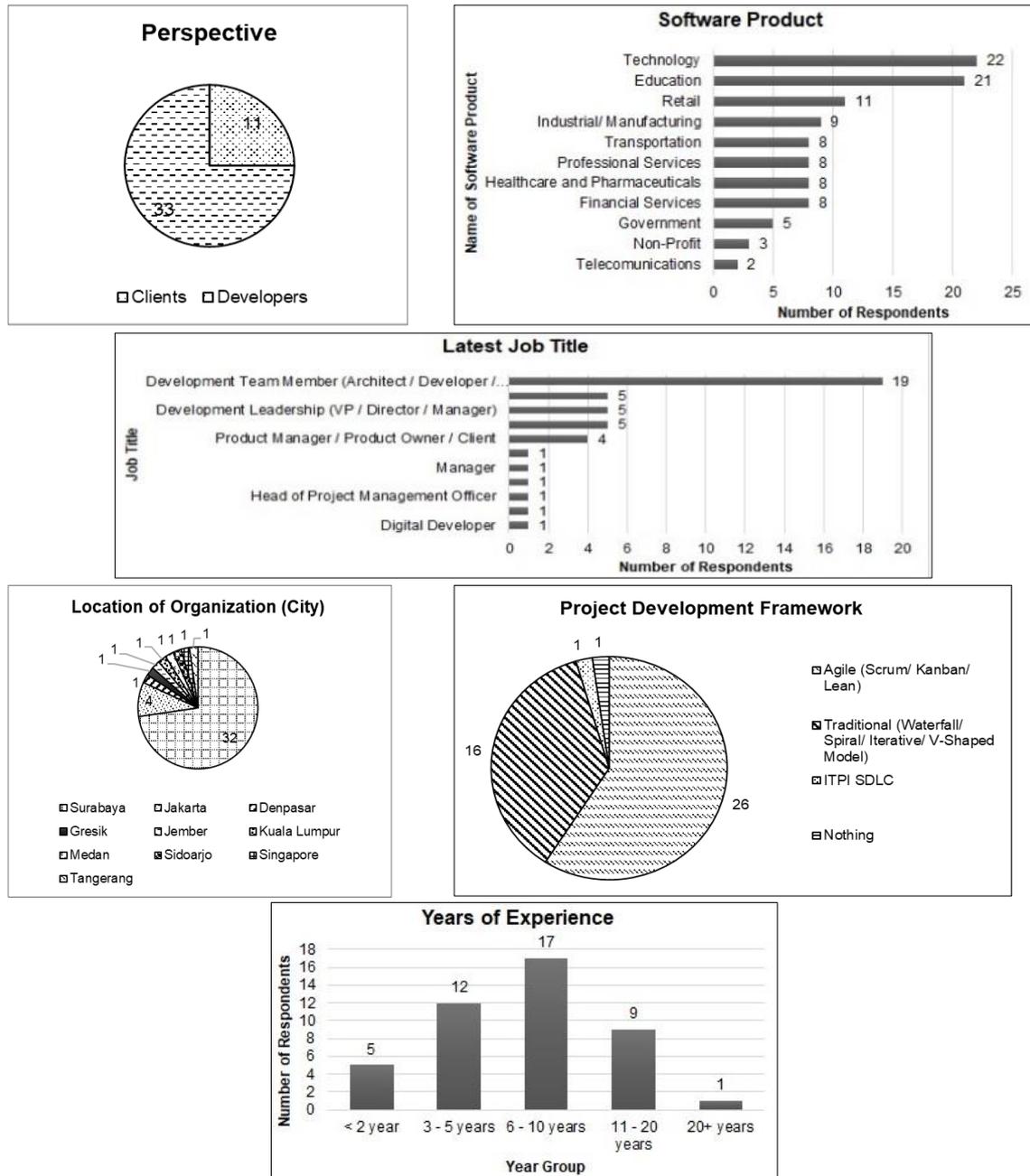


Figure 3. Respondent demographics data

**3.1. Test of reliability and validity**

In order to determine the consistency of various questions within the variables and examine the consistency of respondent choices, it is essential to conduct reliability testing to measure the scale. Cronbach’s alpha was used to test for consistency, with a value 0 (no consistent variance) and 1 (all consistent variance). The higher cronbach’s alpha value indicates greater reliability or accuracy of statistical conclusions. Based on Table 1, it is shown that the statement used is reliable, which can be seen from the cronbach’s alpha value of 0.861 (greater than the lower limit of 0.7) [27]. As seen in Table 2, all CITC values are greater than r-Table R( $\alpha=0.05;df=n-2$ ), which means that all statements are valid.

Table 1. Reliability statistics

Cronbach’s alpha	Number of respondents	Number of items
0.861	44	10

Table 2. Item-total statistics

	CITC	r-table	Result
Business value	0.570	0.2973	Valid
Development cost	0.349	0.2973	Valid
Risk	0.674	0.2973	Valid
Time to market	0.606	0.2973	Valid
Dependencies	0.705	0.2973	Valid
Effort estimation	0.528	0.2973	Valid
Schedule	0.633	0.2973	Valid
Volatility	0.564	0.2973	Valid
Implementation effort	0.572	0.2973	Valid
Stakeholder satisfaction	0.502	0.2973	Valid

### 3.2. Descriptive statistics

This section explains the importance of the research variables in providing a comprehensive overview of the research. The primary objective of descriptive analysis is to assess the significance of criteria, examine the interrelation among them, and employ the decision tree method for categorizing criteria within the BOCR framework. Further discussion has been narrowed down to the following topics: the importance of criteria in prioritization requirements, the correlation coefficient criteria, classification of criteria based on BOCR, and influence of stakeholder's perspective on weighting requirements prioritization

#### 3.2.1. The importance of criteria in prioritization requirements

The survey resulting in how important a criterion affects requirements prioritization are shown in the percentage form. The criteria that have the greatest percentage of responses indicating extremely important levels are business value and stakeholder satisfaction, as shown in Figure 4. Furthermore, the relationship perspective and the percentage of the criteria (e.g. business value, dependencies, effort estimation/size measurement, schedule, volatility, risk, time to market, implementation effort, development cost, stakeholder satisfaction) is displayed in the form of a scatter chart with two dimensions showing the relationship two variables see in Figure 5.

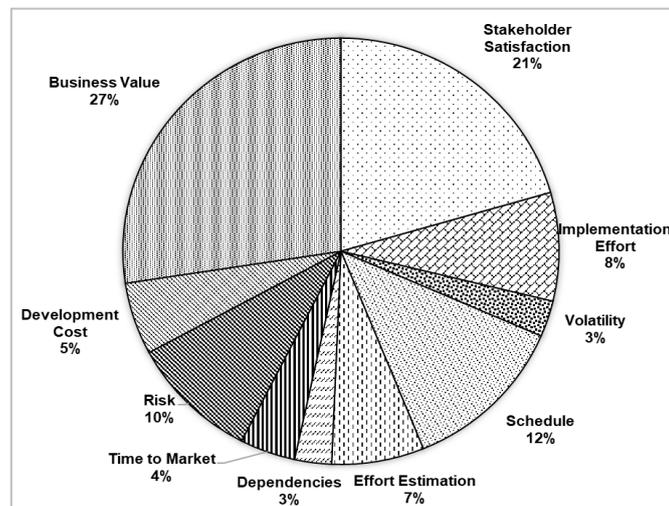


Figure 4. The percentage of important criteria in requirements prioritization

In the scatter chart, there are two groups: the client perspective and the developer perspective, which tend to move in the same direction and in the opposite direction. Perspectives that move in the same direction -regarding the percentage of criteria to the level of importance of a criterion -are business value, dependencies, effort estimation, schedule and volatility. On the other hand, the remaining criteria, namely development cost, risk, time to market, implementation effort, and stakeholder satisfaction, exhibit a contrasting trend or move in the opposite direction. If the scatter chart moves in the same direction, the level of importance of the criteria for all perspectives is the same (1 (not all important) to 7 (extremely important)). On the other hand, if it moves in the opposite direction, the level of importance of the client's perspective is different from the developer's perspective.

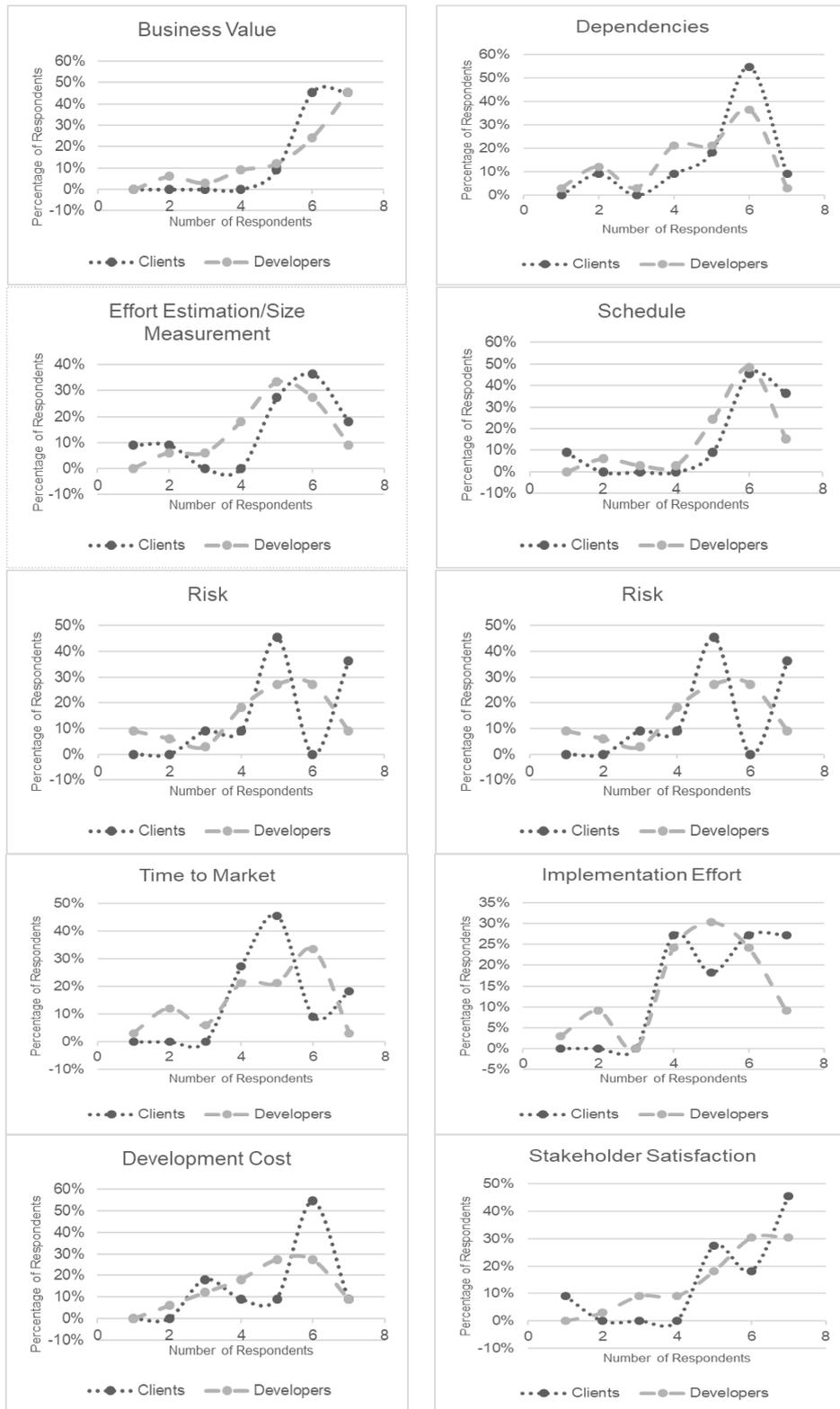


Figure 5. Scatter chart of perspective and percentages of criteria

**3.2.2. The correlation coefficient criteria**

Additionally, the connection the criteria employed in the requirements prioritization process is determined through a correlation test. Correlation, in general, is a statistical measure that quantifies the degree of linear association two variables [28]. It is useful for describing simple relationships variables without

implying causation. The correlation coefficient, which signifies the strength of the relationship two variables, is calculated using the following formula:

$$r_{xy} = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}} \quad (1)$$

where:

$r_{xy}$ : correlation coefficient x and y

$X_i$ : the values of x within a sample

$\bar{X}$ : the mean of the values of x

$Y_i$ : the values of y within a sample

$\bar{Y}$ : the mean of the values of y

The results of calculating the correlation on the criteria can be seen in Table 3. All the criteria show a positive correlation, indicating that the variables tend to move in the same direction. In other words, the other tends to increase when one variable increases. Further details regarding the strength of the correlations are provided in Table 4. For example, the interpretation of the correlation business value and risk produces a correlation value of 0.583, meaning that the business value variable and the risk variable have a positive and strong relationship.

Table 3. The correlation coefficient criteria

	Business value	Development cost	Risk	Time to market	Dependencies	Effort estimation	Schedule	Volatility	Implementation effort	Stakeholder satisfaction
Business value	1	0,417	0,583	0,588	0,477	0,155	0,242	0,291	0,468	0,210
Development cost	0,417	1	0,318	0,51	0,189	0,106	0,077	0,179	0,284	0,104
Risk	0,583	0,318	1	0,595	0,729	0,302	0,448	0,391	0,273	0,372
Time to market	0,588	0,51	0,595	1	0,5	0,199	0,247	0,401	0,32	0,279
Dependencies	0,477	0,189	0,729	0,5	1	0,554	0,542	0,391	0,405	0,361
Effort estimation	0,155	0,106	0,302	0,199	0,554	1	0,646	0,367	0,458	0,418
Schedule	0,242	0,077	0,448	0,247	0,542	0,646	1	0,584	0,373	0,585
Volatility	0,291	0,179	0,391	0,401	0,391	0,367	0,584	1	0,484	0,327
Implementation effort	0,468	0,284	0,273	0,32	0,405	0,458	0,373	0,484	1	0,405
Stakeholder satisfaction	0,210	0,104	0,372	0,279	0,361	0,418	0,585	0,327	0,405	1

Table 4. Correlation coefficient scale

Correlation coefficient value	Association
-0.3 to+0.3	Weak
-0.5 to -0.3 or 0.3 to 0.5	Moderate
-0.9 to -0.5 or 0.5 to 0.9	Strong
-1.0 to -0.9 or 0.9 to 1.0	Very strong

### 3.2.3. Classification of criteria based on BOCR

The third phase involves surveying to categorize the 38 criteria identified through the literature review. These criteria are classified based on the BOCR developed by Saaty [29], which includes factors such as benefits (B), opportunities (O), costs (C), and risks (R). The benefits of opportunities represent the potential gains or expected outcomes when selecting requirements as work priorities. On the other hand, costs and risks may also be associated with meeting these requirements.

Moreover, the decision tree is used to classify the criteria into their respective factors: benefits, opportunities, costs, or risks. Figure 6 illustrates the decision tree used in this process. The term “beneficial” denotes a higher value being favorable, while “non-beneficial” implies a lower value being preferable. Positive outcomes or gains are referred to as benefits, whereas negative outcomes are regarded as costs. Additionally, the decision tree accounts for uncertain factors, including potential gains known as opportunities and potential losses known as risks, associated with the decision-making process [30].

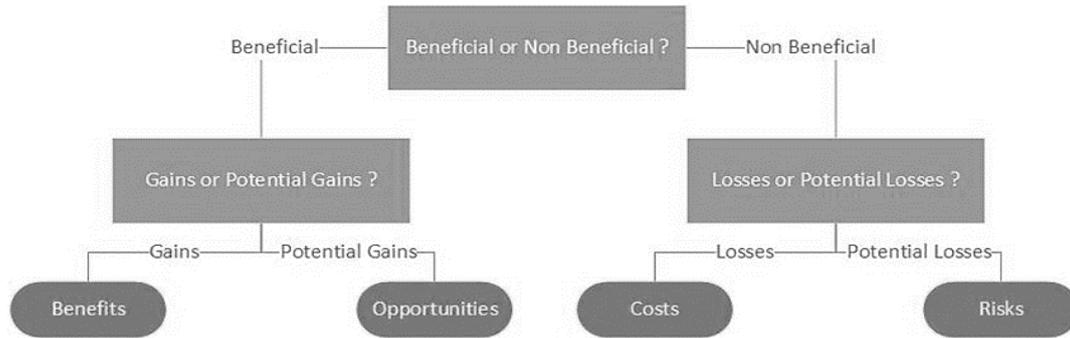


Figure 6. The decision tree based on BOCR factor for classification of requirements prioritization criteria

For this survey, 9 experts were surveyed and interviewed. The most important criterion for the expert here is someone with experience in software engineering with a developer or client perspective. The expert’s demographic can be seen in Table 5.

Table 5. Demographic analysis of experts

#	Year of experience	Latest job title
E1	9 years	Product manager
E2	19 years	Development leadership
E3	8 years	System analyst
E4	8 years	Product manager
E5	16 years	C-level executive
E6	14 years	Program manager
E7	5 years	System analyst
E8	20 years	Program manager
E9	5 years	Product owner

Table 6 is the result of grouping criteria based on BOCR into different categories and factors related to the analysis of benefits, opportunities, costs, and risks. Utilizing the decision tree method in Figure 6 along with the criteria outlined in Figure 2, the expert allocated each criterion into the respective categories of benefits, opportunities, costs, and risks. In the “benefits” section, several factors that contribute to the positive aspects of a project or endeavor. These factors include “business value,” “importance,” “stakeholder satisfaction,” “quality,” and “impact.” These elements represent various criteria used to evaluate the potential benefits of a particular initiative. In the “opportunities” section, lists of factors that present potential advantages for the project are: “availability of resources,” “authority,” “scalability,” “developers’ input,” and “visibility.” These factors are considered as potential opportunities to leverage for the success of the project. The “costs” section enumerates factors related to the financial expenses or resource investment required for the project. It includes “development cost,” “effort estimation,” and “implementation effort.” These factors indicate various cost-related considerations. The “risks” section outlines factors that pose potential challenges or threats to the project’s success. These factors include “risk,” “time to market,” “dependencies,” “schedule,” “volatility,” “complexity,” “penalty,” “learning experience,” “external change,” and “uncertainties.” These elements represent a range of risks that the project might encounter.

Table 6. The criteria based on BOCR

	Business value	Importance	Stakeholder satisfaction	Quality	Impact
Benefits	Knowledge	Strategic	Usability	Technical feasibility	Customer input
	Performance	Ease of use	Accuracy	Trust	Applicability
	Reliability	Urgency			
Opportunities	Available of resources	Authority	Scalability	Developers’ input	Visibility
	Sales	Marketing			
Costs	Development cost	Effort estimation	Implementation effort		
Risks	Risk	Time to market	Dependencies	Schedule	Volatility
	Complexity	Penalty	Learning experience	External change	Uncertainties
	Negative value				

From the results of the survey, there are 17 criteria in the benefits group, 7 criteria in the opportunities group, 3 criteria in the costs group and 11 criteria in the risks group. After grouping the criteria, an in-depth interview that discusses several criteria that are not strongly grouped (less than 50% are selected, or less than 5 respondents chose) are conducted. The four criteria that are not strongly grouped are availability of resources, schedule, importance and urgency. Based on the in-depth interview, availability of resources is included in the category of opportunities because the resource is already available, not unavailable, so it is considered a risk. The schedule criteria are included in the risk not cost group because of the uncertainty that this schedule will incur costs or not. Meanwhile, the importance criteria are included in the category of benefits, not opportunities, because the important requirements must be an advantage immediately felt by the benefits. The grouping is quite spread out in all categories for the urgency criteria. However, it is more inclined to be in the benefits category because if the requirements are urgent to be implemented, the benefits must be immense.

Two other interesting criteria are discussed during in-depth interviews: learning experience and time to market. The learning experience criteria will benefit if the learning has been carried out before the software development stage. However, it will be risky if the learning is carried out in conjunction with the software development process. The time-to-market criteria are categorized as opportunities if the software is made right to be released to the market. However, if the time-to-market criteria are estimated, the time-to-market criteria are more appropriate to be included in the risk category.

### **3.3. Effect of project context characteristics on requirements prioritization**

Requirements prioritization is a decision-making process led by stakeholders. Alongside the criteria employed and stakeholder perspectives, the project context is crucial in influencing requirement selection. The project context encompasses four key characteristics in the requirements prioritization process: (i) type of engagement, such as a single external client, collaborative external client, or inter-departmental project; (ii) scope, which can be categorized as small, medium, or large; (iii) the number of team members involved, and (iv) the contractual agreement specifying the pricing structure and project duration, which can be either fixed-price/fixed-duration or allow flexibility in the timeline [31].

### **3.4. Influence of stakeholder's perspective on weighting requirements prioritization**

Client-developer collaboration is a very well-known process in requirements prioritization. Win-win collaboration clients and developers can balance client's value and developer's value [31]. The client's and developers' perspectives differ depending on project-specific context factors. Including the client's and developer's perspectives in the requirements prioritization process is necessary [32].

## **4. CONCLUSION**

The most popular criteria, according to descriptive statistics, are business value and stakeholder satisfaction. Client- and developer-focused respondents scored both criteria with a very high percentage. Every criterion exhibits a positive correlation, which means that as the value of one criterion rises, so does the value of the others. Due to the fact that the development cost and schedule have been fixedly defined and are based on predetermined criteria, the association between schedule and development cost is that the higher the schedule, the less influence it has on the high development cost. The grouping of criteria based on BOCR separates the 38 criteria generated in the SLR into 4 (four) BOCR groups. It is important to create client-developer collaboration in the requirements selection process to balance the value the client's perspective and the developer's perspective. Using a survey-based empirical (quantitative) methodology, this study categorises factors used in requirements prioritisation from the views of stakeholders (both clients and developers). It highlights the significance of these requirements for software development. While open-ended questions solicit expert perspectives, closed questions evaluate importance and correlations. Contributions include highlighting the significance of client-developer collaboration, identifying key criteria (business value and stakeholder satisfaction), establishing positive correlations among criteria, grouping them into benefits, opportunities, costs, and risks, and recognising project-specific characteristics. These conclusions can be verified by more study by using them in actual projects.

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## REFERENCES

- [1] K. Abdelazim, R. Moawad, and E. Elfakharany, "A framework for requirements prioritization process in Agile software development," *Journal of Physics: Conference Series*, vol. 1454, no. 1, p. 012001, Feb. 2020, doi: 10.1088/1742-6596/1454/1/012001.
- [2] A. Rasheed *et al.*, "Requirement engineering challenges in Agile software development," *Mathematical Problems in Engineering*, vol. 2021, pp. 1–18, May 2021, doi: 10.1155/2021/6696695.
- [3] T. Amelia and R. B. Mohamed, "A proposed requirements prioritization model based on cost-value approach with collaboration perspective," in *Proceedings - 2021 International Conference on Software Engineering and Computer Systems and 4th International Conference on Computational Science and Information Management, ICSECS-ICOCSIM 2021*, Aug. 2021, pp. 10–15, doi: 10.1109/ICSECS52883.2021.00009.
- [4] F. Hujainah, R. A. Bakar, E. Alhroob, B. Al-Haimi, and A. B. Nasser, "Interrelated elements in formulating an efficient requirements prioritization technique: review," in *Proceedings - 10th IEEE International Conference on Control System, Computing and Engineering, ICCSCE 2020*, Aug. 2020, pp. 97–101, doi: 10.1109/ICCSCE50387.2020.9204955.
- [5] A. R. Asghar, S. N. Bhatti, A. Tabassum, Z. Sultan, and R. Abbas, "Role of requirements elicitation & prioritization to optimize quality in scrum Agile development," *International Journal of Advanced Computer Science and Applications*, vol. 7, no. 12, pp. 300–306, 2016, doi: 10.14569/IJACSA.2016.071239.
- [6] M. Hussain, H. U. Khan, A. W. Khan, and S. U. Khan, "Prioritizing the issues extracted for getting right people on right project in software project management from vendors' perspective," *IEEE Access*, vol. 9, pp. 8718–8732, 2021, doi: 10.1109/ACCESS.2021.3049226.
- [7] G. D. Rottoli and C. Casanova, "Multi-criteria and multi-expert requirement prioritization using fuzzy linguistic labels," *ParadigmPlus*, vol. 3, no. 1, pp. 1–18, Feb. 2022, doi: 10.55969/paradigmplus.v3n1a1.
- [8] Z. Bakalova, M. Daneva, A. Herrmann, and R. Wieringa, "Agile requirements prioritization: what happens in practice and what is described in literature," in *Requirements Engineering: Foundation for Software Quality, Springer, Berlin Heidelberg*, 2011, pp. 181–195, doi: 10.1007/978-3-642-19858-8\_18.
- [9] J. Karlsson and K. Ryan, "A cost-value-approach for prioritizing requirements," *IEEE Software*, vol. 14, no. 5, pp. 67–74, 1997, doi: 10.1109/52.605933.
- [10] A. H. E. Bakly and N. R. Darwish, "A fuzzy approach for wieger's method to rank priorities in requirement engineering," *CIT*, no. November, 2017.
- [11] M. Amiri and F. Golozari, "Application of fuzzy multi-attribute decision making in determining the critical path by using time, cost, risk, and quality criteria," *International Journal of Advanced Manufacturing Technology*, vol. 54, no. 1–4, pp. 393–401, Apr. 2011, doi: 10.1007/s00170-010-2928-4.
- [12] N. Riegel and J. Doerr, "A systematic literature review of requirements prioritization criteria," in *International Working Conference on Requirements Engineering: Foundation for Software Quality*, 2015, pp. 300–317, doi: 10.1007/978-3-642-37422-7.
- [13] I. Olaronke, I. Rhoda, and G. Ishaya, "An appraisal of software requirement prioritization techniques," *Asian Journal of Research in Computer Science*, pp. 1–16, Apr. 2018, doi: 10.9734/ajrcos/2018/v1i124717.
- [14] F. Hujainah, R. B. A. Bakar, M. A. Abdulgaber, and K. Z. Zamli, "Software requirements prioritisation: a systematic literature review on significance, stakeholders, techniques and challenges," *IEEE Access*, vol. 6, pp. 71497–71523, 2018, doi: 10.1109/ACCESS.2018.2881755.
- [15] I. P. Gambo, R. N. Ikono, P. O. Achimugu, and O. G. Iroju, "A ranking model for software requirements prioritization during requirements engineering: a case study," *International Journal of Computer Science and Information Security (IJCSIS)*, vol. 16, no. 4, 2018.
- [16] P. Achimugu, A. Selamat, and R. Ibrahim, "ReproTizer: a fully implemented software requirements prioritization tool," *Transactions on Computational Collective Intelligence XXII*, vol. 9655, pp. 80–105, 2016, doi: 10.1007/978-3-662-49619-0.
- [17] S. U. R. Khan, S. P. Lee, M. Dabbagh, M. Tahir, M. Khan, and M. Arif, "RePizer: a framework for prioritization of software requirements," *Frontiers of Information Technology and Electronic Engineering*, vol. 17, no. 8, pp. 750–765, Aug. 2016, doi: 10.1631/FITEE.1500162.
- [18] J. McZara, S. Sarkani, T. Holzer, and T. Eveleigh, "Software requirements prioritization and selection using linguistic tools and constraint solvers—a controlled experiment," *Empirical Software Engineering*, vol. 20, no. 6, pp. 1721–1761, Dec. 2015, doi: 10.1007/s10664-014-9334-8.
- [19] T. Amelia and R. Mohamed, "A review: requirements prioritization criteria within collaboration perspective," *Pertanika Journal of Science and Technology*, vol. 31, no. 1, pp. 161–185, Oct. 2023, doi: 10.47836/pjst.31.1.11.
- [20] M. Sufian, Z. Khan, S. Rehman, and W. H. Butt, "A systematic literature review: software requirements prioritization techniques," in *Proceedings - 2018 International Conference on Frontiers of Information Technology, FIT 2018*, Dec. 2019, pp. 35–40, doi: 10.1109/FIT.2018.00014.
- [21] F. Sher, D. N. A. Jawawi, and R. Mohammad, "Requirements prioritization aspects quantification for value-based software developments," *Journal of Theoretical and Applied Information Technology*, vol. 97, no. 14, pp. 3969–3979, 2019.
- [22] A. Sureka, "Requirements prioritization and next-release problem under non-additive value conditions," in *Proceedings of the Australian Software Engineering Conference, ASWEC*, Apr. 2014, pp. 120–123, doi: 10.1109/ASWEC.2014.12.
- [23] S. M. K. Samarakoon and R. M. C. Ratnayake, "Strengthening, modification and repair techniques' prioritization for structural integrity control of ageing offshore structures," *Reliability Engineering and System Safety*, vol. 135, pp. 15–26, Mar. 2015, doi: 10.1016/j.res.2014.10.023.
- [24] C. J. Torrecilla-Salinas, J. Sedeño, M. J. Escalona, and M. Mejías, "Estimating, planning and managing Agile web development projects under a value-based perspective," *Information and Software Technology*, vol. 61, pp. 124–144, May 2015, doi: 10.1016/j.infsof.2015.01.006.
- [25] S. Devulapalli, O. Rao, and A. Khare, "Requirements prioritization—parameters of relevance—an empirical study across 3 datasets," *Proceedings of the Second International Conference on Information and Communication Technology for Competitive Strategies*, 2016, doi: 10.1145/2905055.2905340.
- [26] Z. Racheva, M. Daneva, and A. Herrmann, "A conceptual model of client-driven Agile requirements prioritization: Results of a case study," in *ESEM 2010 - Proceedings of the 2010 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement*, Sep. 2010, pp. 1–4, doi: 10.1145/1852786.1852837.
- [27] J. F. H. Jr, W. C. Black, B. J. Babin, R. E. Anderson, W. C. Black, and R. E. Anderson, *Multivariate data analysis eighth edition*, Eighth Edi. Cengage Learning EMEA, 2019.

- [28] F. Hujainah, R. Binti Abu Bakar, A. B. Nasser, B. Al-haimi, and K. Z. Zamli, "SRPTackle: a semi-automated requirements prioritisation technique for scalable requirements of software system projects," *Information and Software Technology*, vol. 131, p. 106501, Mar. 2021, doi: 10.1016/j.infsof.2020.106501.
- [29] T. L. Saaty, "The analytic hierarchy and analytic network processes for the measurement of intangible criteria and for decision-making," in *Multi Criteria Decision Analysis: State of the Art Surveys*, J. Figueira, S. Greco, and M. Ehrgott, Eds. New York: Springer, 2005, pp. 345–407.
- [30] R. Sarmiento and K. X. Vargas-Berrones, "Modeling the implementation of green initiatives: an AHP-BOCR approach," *Cogent Engineering*, vol. 5, no. 1, p. 1432120, Jan. 2018, doi: 10.1080/23311916.2018.1432120.
- [31] M. Daneva *et al.*, "Agile requirements prioritization in large-scale outsourced system projects: an empirical study," *Journal of Systems and Software*, vol. 86, no. 5, pp. 1333–1353, May 2013, doi: 10.1016/j.jss.2012.12.046.
- [32] H. Hamdani, R. Wardoyo, and K. Mustofa, "Weighting model for group decision support system: a review," *Indonesian Journal of Electrical Engineering and Computer Science (IJECS)*, vol. 11, no. 3, pp. 962–974, Sep. 2018, doi: 10.11591/ijeecs.v11.i3.pp962-974.

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