Risk management for energy efficiency in information technology project: a case of a government agencies in Indonesia

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Abstract. The Research and Development Agency and Books Secretariat is a government organizational unit that uses vendor services (outsourcing) in information technology (IT) projects. However, outsourcing does not guarantee that the project will run successfully (on time, within the estimated cost, and satisfactorily). Several examples of IT project outsourcing failures demonstrate the critical role of risk management. One of the frameworks used to develop risk management is the Project Management Body of Knowledge (PMBOK) approach. In this study, the level of risk is measured using quantitative methods. The results show that outsourcing IT projects with a reasonably high risk is found in analysing user requirements, project time, and vendor staff qualifications. Risk response planning and risk monitoring are critical stages after the risk level has been identified. The implementation of risk management is expected to be a guideline for organizations in implementing IT project outsourcing, thereby increasing the chances of project success.

1. Introduction
The Research and Development Agency and Books Secretariat (SRDBA) is a government organizational unit that carries out administrative services and coordinates the implementation of organizational unit tasks and administrative affairs within the Research and Development and Book Affair Agency [1]. As it befits a government organization at this time, the SRDBA has also applied the application of information technology (IT) in supporting its duties and functions. As a result, various applications were developed to help ease work, provide a competitive advantage between organizational units within the ministry, and increase service satisfaction for stakeholders. It is expected that the development of IT application could enhance work efficiency which in turn could optimize energy efficiency.

In implementing IT development projects, the SRDBA not only does it themselves, but some also use vendors (outsourcing). However, outsourcing also does not guarantee a smooth IT project implementation. Various obstacles also arise in implementing IT project outsourcing (ITPO) at the SRDBA, such as project completion that is not on time. The final result of the project is not following the objectives. These costs exceed the estimated initial calculation. Based on the results of interviews, from 2011 to 2020, only one of the eight IT projects that outsourced was successful. A joint research study between McKinsey and the University of Oxford found that, on average, software development projects ran 66% over budget and 33% over schedule, and 17% of projects turned out to be so bad that the system posed a risk to the company [2]. Another result of research conducted by Standish Group
International in the period 2011-2015 on fifty thousand IT projects around the world (mainly in America and Europe) showed that on average, only 28.8% of IT projects were included in successful criteria [3]. The successful measures indicate that the project can be completed on time according to the estimated cost (on the budget) and satisfactory results. Meanwhile, in Indonesia itself, the success rate of IT projects in Indonesia is still relatively low, namely 27% [4].

Based on the explanation above, to reduce the risks that may arise and lead to failure in implementing IT outsourcing projects, the SRDBA requires risk management to prevent or prevent unwanted risks in implementing IT outsourcing projects. Therefore, the questions in this study can be formulated. The implementation of risk management is appropriate for the SRDBA to be carried out successfully according to the objectives. Therefore, this research aims to compile the application of risk management to assist in decision-making during the planning and implementation of ITPO in the SRDBA environment.

2. Literature Review

A project is a work that is done to create a product or service that is unique [5]. Meanwhile, a project is a provisional effort to create a specific product or service [6]. In common, a project implicates some people associated with their action and the project's main sponsor involved in the effective use of assets to finish the project efficiently and timely.

2.1. IT outsourcing

IT outsourcing is the use of IT products or services from vendors outside our organization. The main benefit of outsourcing is reducing fixed and operational costs to focus more on its core business and improve its internal business processes [7].

2.2. Project Risk Management

Project risk is an uncertain condition or event that can positively or negatively affect the project [8]. Meanwhile, the risk is an uncertain event or condition which, if it occurs, can affect at least one project goal [9]. A risk has a cause and can have an impact. For example, risk can impact the project's cost, schedule, and quality in an IT project. Risk management is a science or art used to identify, analyze, respond to, and control existing risks [10]. This management aims to eliminate or reduce the negative impact of risk to an acceptable tolerance point and with excellent management. Risk management is managing risk and minimizing failure, which includes technical, cost, and schedule aspects for software developers [11]. Several techniques are used to manage the risk of a project, including the approach using Project Management Body of Knowledge (PMBOK) and Projects in Controlled Environment (PRINCE2). According to [5], the definition of risk management is a formal systematic management method concentrates on identifying, analyzing, and controlling risk factors, areas, or events that may cause undesired changes during project implementation.

There are ten knowledge areas in PMBOK, one of which is Project Risk Management (PRM), as shown in Error! Reference source not found.. The purpose of PRM itself is to escalate the possibility and impact of positive events and reduce the likelihood and impact of adverse events in the project to be worked. PRM includes several processes. A risk management plan is the process of defining how to carry out risk management activities for a project. Identify risk is identifying project risk and sources of overall project risk and documenting its characteristics. Perform qualitative analysis is to prioritize risks for further research or action by assessing and combining the probability of occurrence and impact of these risks. Performing a quantitative analysis is the process of analyzing the combined effect of the identified individual project risks and other sources of uncertainty on the overall project objectives in a numerical way. Plan risk responses are the process of developing options, selecting strategies, and agreeing on actions to deal with the overall project risk, as well as for dealing with project risk. Implement risk responses are the process of implementing an approved risk response plan. Finally, risk monitoring is the process of monitoring the implementation of an agreed risk response plan, tracking
identified risks, identifying and analyzing new threats, and evaluating the effectiveness of risk processes throughout the project.

Meanwhile, according to PRINCE2, the risk management procedure consists of five steps: identify (context and risk), assess (estimate and evaluate), plan, implement, and communicate. The first four steps are sequential, whereas the fifth step operates in parallel as the output of any other actions may need to be communicated to stakeholders at any point in the process [12]. Choosing the PMBOK approach is because it is more detailed in identifying risks by using numerical analysis of the likelihood and impact of risks. PRINCE2 does not take a specific approach to risk management [12]. PMBOK and PRINCE2 can be used to complement each other [13]. These two project management approaches are interconnected and complimentary, with PRINCE2 adding value to the PMBOK knowledge base [14].

3. Research Methodology
In general, the concept of this research is a case study to identify and analyze risks in ITPO in the SRDBA. The research steps carried out in this study are divided into six stages as follows (Figure 2):
- Data Collection. At this stage, data collection is carried out through documents and interviews. A list of issues related to an IT project is compiled through interviews with relevant procurement officials and employees in the IT sector regarding common risks.
- Literature Study. This process is carried out to learn things related to IT PRM from previous research studies. Literature studies conducted using sources from books and journals that discuss IT PRM and PMBOK.
- Identification of Risk Management. At this stage, the various risks that may arise during the project are identified.
- Identification of PMBOK Approach. This process carries out risk management mapping into the risk management area in PMBOK.
- Development of a Risk Management Model. At this stage, the outsourcing IT PRM model is prepared in the SRDBA.
- Validation. At this stage, the validation of the risk management model is carried out by conducting interviews with officials who can make policies.

4. Results and Discussion
In previous research, conducted at construction companies, the resulting measurement of risk levels is the basis for decision making, risk response, and risk mitigation [15]. Researched the same technique to measure the risk of project implementation on performance, cost, and time [16]. Meanwhile, a study on the success and failure rates of information system projects in Indonesia [4]. The three studies used the
same risk measurement techniques, namely severity index (SI) and probability impact matrix (PIM). Meanwhile, researched the risk factors and variables of delay in project implementation using the PMBOK approach [17]. In this study, measuring the level of risk was carried out using SI and PIM and developing risk management using the PMBOK approach. Furthermore, the determination of risk factors and variables is taken from research conducted, regarding the factors that can cause companies to adopt outsourcing in information system services [18].

Outsourcing in implementing IT projects at the SDRBA was carried out due to limited human resources (HR) at the SDRBA, especially in quantity. So that many IT projects are outsourced to vendors. The selection of vendors who will work on IT projects is carried out under applicable laws and regulations, namely by using procurements. Vendors who meet the selection criteria until they are selected will start working on the IT project after the contract agreement is made between the two parties. After completing the vendor's IT project work, the resulting application will belong to the SDRBA along with the source program code.

4.1. Plan Risk Management
Based on the results of data collection through interviews with procurement officials, it is known that the SDRBA has never carried out an IT PRM plan. In addition, the SDRBA does not yet have a database on risks. As a result, the SDRBA has not documented the policies, knowledge, and experience of the dangers of outsourcing IT projects that have been carried out.

Meanwhile, in terms of risk, the SDRBA has not categorized the types of risk in writing, and only in the form of mutual agreement with vendors that the risk of outsourcing IT projects is considerable. Meanwhile, planning and risk analysis for rules and responsibilities, allocation of funds, timeframe, and activity report format have been prepared in a cooperation contract with the vendor. In addition, data and documents from the SDRBA database, organizational assets, and project scope can be used as input for the ITPO risk planning analysis process.

4.2. Identify Risk
In identifying these risks, risk factors for outsourcing IS are used [18]. The risk factors shown in the research are pretty specific and cover aspects of ITPO, including general risk, vendor risk, and user risk. The next step is to create a risk register using a diagrammatic technique in the form of a Risk Breakdown Structure (RBS), as shown in Figure 3.

4.3. Perform Quantitative and Qualitative Analysis
Based on the RBS at the risk identification stage and filling out a questionnaire with the same weight from the respondents, four IT employees, and one goods/services procurement officer at the SRDBA,
qualitative and quantitative risk analysis can be carried out. The risk analysis process uses the Severity Index (SI) method to obtain a combination of probability assessments and risk impacts. The following is the calculation formula for SI (Q1):

$$SI = \frac{\sum_{i=0}^{4} y_i r_i}{\sum_{i=0}^{4} r_i} \times 100\%$$

(1)

where:

- $y_i$ = assessment constant
- $r_i$ = frequency of respondents
- $i = 0, 1, 2, 3, 4, ..., n$

with:

- $r_0, r_1, r_2, r_3, r_4$ is the frequency response of respondents
- $y_0 = 0, y_1 = 1, y_2 = 2, y_3 = 3, y_4 = 4$
- $r_0$ = respondent frequency "very low", then $y_1 = 1$
- $r_1$ = respondent frequency "low", then $y_2 = 2$
- $r_2$ = respondent frequency "quite high", then $y_3 = 3$
- $r_4$ = respondent frequency "very high", then $y_4 = 4$

The classification of the rating scales on probability and impact is as in Table 1. While the results of the analysis of the probability assessment and risk impact with the SI method can be seen in Table 2 and Table 3.

**Table 1. Probability and Impact Measurement Scale**

| Scale | Probability (P) | Impact (I) | SI Value (%) |
|-------|-----------------|------------|--------------|
| 1     | Very Low (SR)   | Very Small (SK) | 0 <= SI < 12,5 |
| 2     | Low (R)         | Small (K)  | 12,5 <= SI < 37,5 |
| 3     | Quite High (C)  | Medium (S) | 37,5 <= SI < 62,5 |
| 4     | High (T)        | Big (B)    | 62,5 <= SI < 87,5 |
| 5     | Very High (ST)  | Very Big (SB) | 87,5 <= SI < 100 |

The analysis of the probability assessment and risk impact using the SI method can be seen in Table 2 and Table 3. In Table 2, the results of the risk probability assessment indicate that the highest risk is in the factor of lack of user/client needs analysis, prolonged processing time, and vendor quality with SI of 75%, and the lowest risk is in the dependency factor with outsourcing rather than in-house. With SI of 30%.

**Table 2. Risk Probability Assessment**

| No | Risk                                | SR | R | C | T | ST | SI | Category |
|----|-------------------------------------|----|---|---|---|----|----|----------|
| R1 | Hidden or out-of-cost outsourcing costs | 0  | 0 | 1 | 4 | 0  | 70 | T (4)    |
| R2 | Security and privacy concerns       | 0  | 0 | 4 | 1 | 0  | 55 | C (3)    |
| R3 | Protracted work time                | 0  | 0 | 0 | 5 | 0  | 75 | T (4)    |
| R4 | Vendor staff quality                | 0  | 0 | 0 | 5 | 0  | 75 | T (4)    |
| R5 | The inability of vendors to adapt to new technologies | 0  | 3 | 2 | 0 | 0  | 35 | R (2)    |
| R6 | Lack of compliance with contracts by vendors | 0  | 2 | 3 | 0 | 0  | 40 | C (3)    |
| R7 | Vendor work does not comply with applicable rules and conditions | 0  | 1 | 4 | 0 | 0  | 45 | C (3)    |
| R8 | Dependence on outsourcing rather than inhouse | 0  | 4 | 1 | 0 | 0  | 30 | C (3)    |
| R9 | Lack of analysis of user/client needs | 0  | 0 | 0 | 5 | 0  | 75 | T (4)    |
While the results of the risk impact assessment, as in Table 3, show the most significant impact on the qualifications of vendor staff and the lack of user needs analysis with SI at 95%.

Table 3. Risk Impact Assessment

| No | Risk                                                   | SK | K | S | B | SB | SI | Category |
|----|--------------------------------------------------------|----|---|---|---|----|----|----------|
| R1 | Hidden or out-of-cost outsourcing costs               | 0  | 0 | 0 | 5 | 0  | 75 | B (4)    |
| R2 | Security and privacy concerns                         | 1  | 0 | 2 | 2 | 0  | 50 | S (3)    |
| R3 | Protracted work time                                  | 0  | 0 | 0 | 2 | 3  | 90 | SB (5)   |
| R4 | Vendor staff quality                                  | 0  | 0 | 0 | 1 | 4  | 95 | SB (5)   |
| R5 | The inability of vendors to adapt to new technologies | 0  | 3 | 2 | 0 | 0  | 35 | K (2)    |
| R6 | Lack of compliance with contracts by vendors          | 0  | 2 | 2 | 1 | 0  | 45 | S (3)    |
| R7 | Vendor work does not comply with applicable rules and conditions | 0  | 3 | 2 | 0 | 0  | 35 | K (2)    |
| R8 | Dependence on outsourcing rather than inhouse         | 0  | 4 | 0 | 1 | 0  | 35 | K (2)    |
| R9 | Lack of analysis of user/client needs                 | 0  | 0 | 0 | 1 | 4  | 95 | SB (5)   |

Based on these two results, the subsequent analysis is to measure the risk using the formula (Q2):

\[
R = P \times I
\]

where:
- R = Risk Levels
- P = Probability
- I = Impact

The results of the risk level calculation can be seen in Table 4.

Table 4. Risk Levels

| No | Risk                                                   | P  | I  | R  |
|----|--------------------------------------------------------|----|----|----|
| R1 | Hidden or out-of-cost outsourcing costs               | 4  | 4  | 16 |
| R2 | Security and privacy concerns                         | 3  | 3  | 9  |
| R3 | Protracted work time                                  | 4  | 5  | 20 |
| R4 | Vendor staff quality                                  | 4  | 5  | 20 |
| R5 | The inability of vendors to adapt to new technologies | 2  | 2  | 4  |
| R6 | Lack of compliance with contracts by vendors          | 3  | 3  | 9  |
| R7 | Vendor work does not comply with applicable rules and conditions | 3  | 2  | 6  |
| R8 | Dependence on outsourcing rather than inhouse         | 3  | 2  | 6  |
| R9 | Lack of analysis of user/client needs                 | 4  | 5  | 20 |

The next step is to map the frequency and impact of known risks into the Boston Square Matrix to determine strategies for dealing with threats and determine which are most likely to occur and significantly impact the project. Boston Square Matrix can be seen in Figure 4 [15].
The result of risk level mapping (Table 4) into the Boston Square Matrix (Figure 4) produces the risk level of ITPO in the SRDBA as in Figure 5. High and low categories can be seen from the combination of each impact and risk based on risk identification equipped with risk level mapping.

4.4. Plan Risk Responses
Furthermore, the development of responses to the identified risk events can be done by seeing whether it includes positive or negative risks that will affect what strategy will be used later. The interview results indicated that the identified risks were adverse risks that, if they occurred, could hinder the ITPO process at the SRDBA.

Based on the interview results regarding the type of strategy against risk, a plan to follow up on each risk is generated, as shown in Table 5.

Table 5. Risk Management Strategies

| Risk Variables | Risk Strategies |
|---------------|-----------------|
| R1            | Manage the procurement process well, so that selected vendors can understand and understand the processes related to outsourcing costs, and perform cost analysis by logging the main costs of the activities outsourcingkan |
| R2            | Make rules about access rights to use and use data in the outsourcing process |
| R3            | Create clear work and activity details using the work breakdown structure (WBS), so that all work from resource allocation to job completion percentage can be monitored |
| R4            | Looking at the quality of vendors carefully, ranging from experience to human resources |
| R5            | Pay attention to vendor selection factors and conduct research on technological developments and all software limitations before implementing |
| R6            | Conduct careful vendor selection and develop sufficient SLA to protect client interests |
| R7            | View and learn a vendor's background before deciding to select that vendor |
| R8            | Pay close attention to vendor functions and tasks in terms of IT work functions used, and prioritize in-house activities as long as resources are still available |
| R9            | Always communicate between the client and the vendor, where the client should play an active role in seeing if the necessary needs are covered in the system and have been worth using in supporting the work |
4.5. Implement Risk Responses

The risk management strategy will be implemented by setting out standard operating procedures related to ITPO procurement. After outsourcing IT projects at the SRDBA is executed or carried out, control is carried out by viewing performance reports related to risks that will arise and project progress reports, including time performance, costs, resources, and others. If there are changes that have been approved, they must be documented.

4.6. Monitor Risk

Monitoring ITPO risk is critical because of its unique characteristics. In [19] and [20], nothing regulates this. Based on this, the SRDBA should set more clearly on the level of contract document creation or service level agreement (SLA) because the nature of IT has different characteristics compared to other goods or services. Risk monitoring and development of risk responses prepared previously can be used as input to update the risk management plan for the following ITPO as needed.

4.7. Validation

Data analysis used data collected from respondents, namely ITPO policymakers in the SRDBA, for model validation. From data collection, the following results were obtained:

- Based on experience, the success of IT project development by outsourcing is strongly influenced by three things, namely vendor staff qualifications, not being on time, and not comprehensive user needs analysis. Of the three things included in the "high" risk level, the respondents agree that the risk management that has been prepared contains all the elements, events, and relationships appropriate in the SRDBA.

- The proposed risk management can complement standard operating procedures and procurement procedures so that risks that will arise, especially those of the high type, can be avoided. Respondents agree that risk management can answer model questions.

- The respondents agreed with the risk management of ITPO by giving responses that risk management is excellent to be implemented and will be a reference for the SRDBA in future IT projects.

5. Conclusion

Based on the results, the SRDBA has never planned and or documented ITPO risk management. By identifying the risks that have been carried out, data is obtained that the highest risk in outsourcing IT projects in the SRDBA is a) Protracted processing time; b) Qualification of vendor staff; c) Lack of user needs analysis.

Through the PMBOK approach in developing risk management, strategies is produced to respond to those risks above: a) Using work breakdown structure (WBS) to define and detail the scope of project work to be carried out by providing project status and progress reports, as well as accurate primary input for the project management process and other purposes such as activity definition, network diagrams, program and project schedules, performance reports, risk analysis and mitigation, control tools, or project organization so that all work from the allocation of resources to the percentage of work completion can be monitored; b) Determine the qualifications of the vendor carefully, for example the factor of experience, adequate human resources and others; c) Always communicate between system users and service providers, where the system user is the one who should be the most active because the system user will be able to see whether the necessary requirements have been included in the system and are suitable for use in supporting work.

Based on the validation test results by policymakers, the overall risk management proposed into standard operating procedures has met the need for consideration of decisions on outsourcing information technology projects at the SRDBA.
6. Recommendation
The results of this study have configured the importance of risk management in ITPO. SRDBA is expected to implement risk management in future projects to reduce the potential for project failure. The application of risk management can be implemented by updating the guidelines for implementing projects. Therefore, this study proposes a recommendation and applying risk management to the standard operational procedure (SOP) of ITPO in the SRDBA, as shown in Figure 6.

![Figure 6. Proposed Flow of ITPO SOP Plan](image)

The results of this study are supposed to provide suggestions and input at the review stage of the project proposal so that it can help more accurately decide whether it is necessary or not to execute the project.

References
[1] Anonymous 2019 Regulation of the Minister of Education of the Republic of Indonesia Number 45 of 2019 concerning Organization and Work Procedures of the Ministry of Education and Culture (Republic of Indonesia: Ministry of Education and Culture)
[2] Bloch M, Blumberg S and Laartz J 2012 Harvard Business Review 5 2-7
[3] Anonymous 2015 The Standish Group (The Standish Group International, Inc.)
[4] Apriyanto R D and Putro H P 2018 Seminar Nasional Teknologi Informasi dan Komunikasi (SENITKA 2018) 395-402
[5] Anonymous 2013 A Guide to the Project Management Body of Knowledge (PMBOK Guide) (Pennsylvania: Project Management Institute, Inc)
[6] Schwalbe 2015 An Introduction to Project, Program, and Portfolio Management (USA: An Introduction to Project Management)
[7] Munawar 2005 Fasilkom 3 35-41
[8] Pertiwi H 2017 Jurnal Studi Manajemen dan Bisnis 4 96–108
[9] Budzier A 2012 SSRN Electron. J. 2069959
[10] Kusumadiwati A, Listiana , Hatmoko J U D and Hermawan F 2017 J. Karya Tek. Sipil 6 157–164
[11] Prayogo J S and Setyohadi D B 2017 J. Buana Inform 8 119–130
[12] Axelos 2017 Managing Successful Projects With PRINCE 2 (London : The Stationery Office Ltd)
[13] Fiampolis P and Acaster M 2015 PM World J. Optim. Proj. Manag. with a PRINCE2 Pmb. IV 1–5
[14] Siegelaub J M 2017 International How PRINCE2 ® Can Complement the PMBOK ® Guide and Your PMP ® A Guide to the Project Management Body of Knowledge (PMBOK ® Guide) About PRINCE2 (London : The Stationery Office Ltd)
[15] Widianti U D, Harihayati T and Sufaatin S 2018 407 012087
[16] Yuliana N P I and Rani N M S 2020 MITSU 8 77–88
[17] Simanjuntak M A R and Hermanto H 2020 Prosiding Snitt Poltekba 4 523-529
[18] Gonzalez R, Gasco J and Llopis J 2010 Ind. Manag. Data Syst. 10 284-303
[19] Anonymous 2018 Presidential Regulation Number 16 of 2018 concerning Government Procurement of Goods/Services (Republic of Indonesia: Minister of Law and Human Rights)
[20] Anonymous 2020 Presidential Regulation Number 12 of 2021 concerning Amendments to Presidential Regulation number 16 of 2018 concerning Government Procurement of Goods/Services (Republic of Indonesia: Minister of Law and Human Rights)