Analysis software

by Eunike Endah

Analysis of Software Development Method Selection: A Case of a Private Financial Institution

Eunike Endariahna Surbakti
Faculty of Computer Science, Universitas Indonesia
Depok, Indonesia
+62 21 786 3419
eunikeesurbakti@gmail.com

Betty Purwandari
Faculty of Computer Science, Universitas Indonesia
Depok, Indonesia
+62 21 786 3419
bettyp@cs.ui.ac.id

Iis Solichah
Faculty of Computer Science, Universitas Indonesia
Depok, Indonesia
+62 21 786 3419
iis@cs.ui.ac.

Larastri Kumaralalita
Faculty of Computer Science, Universitas Indonesia
Depok, Indonesia
+62 21 786 3419
larastri@cs.ui.ac.id

ABSTRACT

Software project failures might indicate the need of software development standard procedures within the company. It applies to a private financial institution chosen as a case of this study. The institution has a significant number of software projects completed behind schedule. According to its Key Performance Indicator (KPI), in the second semester of 2007, there were four projects that were not being implemented. Consequently, it brought domino effects and resulted a financial suffer. To address this problem, a research was conducted to reveal the most suitable software development method for the company. Mixed methods were employed in this investigation. The data were collected using interviews and questionnaires to the key stakeholders of the institution along with over ten-year experiences. The respondents were chosen with purposive sampling, while the interviews were based on structured and non-structured questions. The first interview aimed to gather data for the questionnaires, whilst the second interview purposed to validate the results, conclusion, and suggestion of the research. It was started with the Analytic Hierarchy Process (AHP) to rank software development method alternatives based on relevant criteria. The result shows that Rapid Application Development (RAD) is the most suitable software development method for the company, whilst Scrum and waterfall are in the second and third position. RAD could address the problem of project completion delay in the development and design phases by having those phases to be commerce in parallel for faster completion. Then, it was followed by interviews with the stakeholders to explore feasibility to apply RAD as the standard.

CCS Concepts

• Software and its engineering→Software creation and management→Software development process management →Software development methods.

Keywords

Analytic Hierarchy Process; Software Development Process; Software Development Methods.

1. INTRODUCTION

Software project failures are commonly occurred in organizations. A better project management could apply the suitable knowledge, skill, tools, and techniques into the project activities fits to the project needs [12]. The project failure factors are classified into four categories: people, process, technology, and organization, in line with the research about the IT project management in the literature [12].

The institution has not developed any standard procedure in developing software. The past software project proposals from vendors were mostly using the waterfall software development method, which covers requirements, development, testing, and implementation phases. The benefit of the waterfall is that it could plan each phase in detail, thus the project time and cost could be estimated based on the project scope in the beginning of the story [12]. Based on the 2017 Key Performance Indicator (KPI) of the institution, it was expected that there were six software projects to be completed during the year of 2017. However, during the KPI evaluation at the end of the year, only two projects were finished while the rest four projects were delayed. This indicates that the targeted project completion time is not achieved.

There are 474 software projects (containing in house projects and outsource projects) scheduled in the institution during the year of 2013 until 2018, based on the data obtained from the Information Technology Project Management. Among those projects, there were 32 projects completed with a more than 2 years duration, which means the project time target were not achieved, while 104 projects are still ongoing with high risks of delay, as reported by the Deputy Director of the Information Technology Division. Based on the gap between the expectation and reality of the software projects in the institution, some improvement of project management is needed, to create a better working mechanism.

1.1. People

It is the project stakeholders. A good cooperation between the users and developers are needed to understand the business needs in the future, considering all the technology limitations. The most common problem is the difficulty in communication where the Business Analyst who does not understand the technical language, explaining the requirements to the IT and vendors who, in exchange, do not understand the company daily terms.

1.2. Process

It defines the project goals. In the project process, some aspects are monitored e.g. schedule, cost, and quality of the product. Related to the institution current used method, which is waterfall, the most common problem when applying it is that the processes are established in a serial basis. The long process of requirement gathering makes the requirement itself is not suitable with the business needs anymore when the time for software development takes place.

1.3. Technology

Determining the suitable technology could lead to producing the correct product, process, or system. The most common problem in this case is when the top management desires to apply some micro service technology together with the Scrum method. The vendor gives the man days cost. Based on the experience of the institution, the project scope would grow wider which affects the cost, and it would be more difficult to control the vendor's performance.

1.4. Organization

The projects need some clear instruction, strategy, and plan from the organization to direct the project stakeholders. However, the absence of policy and recommended methods in developing the software has been one of the core problems. The organization definitely needs a suitable working mechanism in managing and controlling projects.

Based on the current situation of the institution, the authors form a logic analysis diagram as in Figure 1 to describe the root problem.

Based on the root problem identification, this research focused on the situation that the organization has not developed any Software Development Life Cycle (SDLC) Standard. SDLC has direct effects in how the projects are distributed into phases, and how the project scope and the needed resources are estimated. The SDLC selection is tightly coupled to the project team size, complexity, experience, and skills [12], and also to the characteristic of the software being developed [11]. Therefore, the research question of this study is "What software development method is the most suitable for the institution?"

2. LITERATURE STUDY

2.1. Software Development Method

Software Development Method, sometimes called as the software development process model [18], or software development strategy [12] is an approach to develop software [13]. Software development methods are classified into three categories: plan-driven, agile, and hybrid [3].

There are some examples of the software development methods [18]:

1. Waterfall model, which consists some foundation process: specification, development, validation, and evolution. It also called as requirement specification, software design, implementation, and testing.
2. Incremental development, which consists some processes: specification, development, and validation. This method develops systems by establishing some system versions by gradually adding some functionality to the previous versions.
3. Integration and configuration, which is dependent with the component or reusable system availability. This method develops systems by focusing on configuring those components to be integrated into the new system.
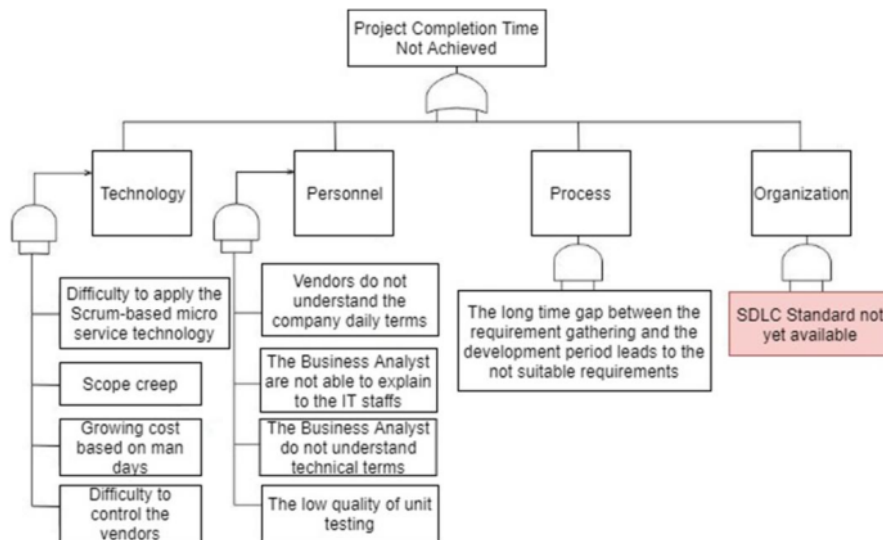

Figure 1. Logic Analysis Diagram

2.2. Multiple Criteria Decision Making (MCDM)

Multiple Criteria Decision Making (MCDM) is a modelling method to handle complicated development. A decision maker faces problems of incomplete and not clear information. The fuzzy set approach is suitable to be used in modelling human knowledge and evaluation by human. There are two basic approach for MCDM: the Multiple Attribute Decision Making (MADM) and the Multiple Objective Decision Making (MODM). The MADM is focused in determining the best option among some contradictory alternatives, while the MODM could handle effectively some unlimited number of related alternatives [8].

In MCDM, AHP is one of the methods. AHP calculation could simulate the human subjective evaluation as a linear function as given in the resulted AHP matrices [1]. AHP is a value measurement method to determine the weight and preference order of a set of alternatives [9].

2.3. Related Works

The AHP method has been used in the literature to determine the most suitable software development method in an organization [7, 9]. A study in determining the most suitable software development method in the Ministry of Foreign Affairs of the Republic of Indonesia, has been carried out by the authors in the previous research [7]. It also used the Analytic Hierarchy Process (AHP) method to conduct the analysis, involving the following factor variables: requirements, applications, businesses, operations, personnel, organizations, and technology, to select the most suitable software development method among the waterfall, Incremental, Prototyping, Extreme Programming, Scrum, and the Rational Unified Process. At the end, it was concluded that Prototyping is the most suitable software development method for the Ministry of Foreign Affairs of the Republic of Indonesia.

The authors also have some experiences in applying the AHP method to determine the most suitable alternative among the available alternatives in an organization, in various contexts:

1. E-voting technology criteria [4]
2. Critical success factors of the Information System development [5]
3. Software failure causes [14]
4. Software development methods in the e-government [7]

Figure 2 gives the research theoretical framework, which consists of the software development methods [1, 9, 10] as the alternatives, and the criteria and sub criteria of the software development method selection from the literature [6, 7, 9, 15, 17, 19]. The alternatives, criteria, and sub criteria are processed using the AHP method to determine the weight of each alternatives, to investigate the most suitable software development method for the institution.
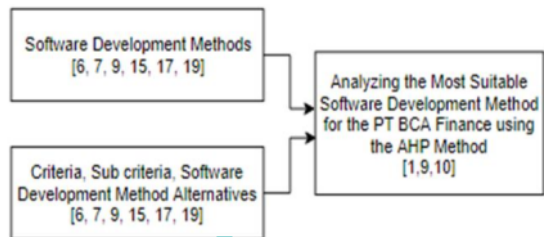

Figure 2. Theoretical Framework

3. RESEARCH METHOD

This research utilised the qualitative approach followed by the quantitative one, as given in Figure 3. The qualitative approach is used to investigate the individual and group influence in the social phenomenon [2], social context and culture in the organization. The qualitative approach is conducted by interviews and literature study, to produce a first list of the alternatives, criteria, and sub criteria. The quantitative approach is conducted by collecting responses from the respondents via pairwise comparison questionnaires, to calculate the weight of each of the criteria and sub criteria, and to further determine the most suitable software development method.

This research is an evaluation case study which evaluate and analyse a case, in the form of activity, process, individuals, or organization, in depth [2]. This research is an exploratory one, because it is conducted to understand the problem better when the available information is not enough yet [16]. In an exploratory research, interviews with the experts are conducted to understand the situation, followed by the discussion.

The data collection is conducted by questionnaires and interviews to the respondents selected via a purposive sampling method. The purposive sampling is usually used in qualitative research to select the respondents based on their individual expertise in accordance with the research subject and objectives, and the diversity of samples in the population [16].

4. RESULTS

The alternatives are the waterfall, Scrum, and RAD methods, while the sub alternatives are analysed and collected by conducting the literature study. The criteria are grouped into four classes based on the software development success factors: personnel, process, technology and organization [13, 18], with the following formulation steps:

1. The requirement criteria is merged with the process criteria.
2. The application criteria is merged with the technology criteria.
3. The operational and business criteria are merged with the organization criteria.
4. The personnel criteria is maintained.

Some merging and deletion of sub criteria are also conducted to obtain a more understandable model [8, 10]. In the personnel
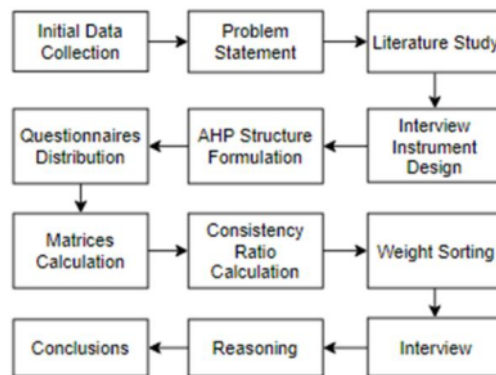

Figure 3. Research Stages

Table 1. Research Hierarchy Structure

Level 0 (Research Goal)	Level 1 (Criteria)	Level 2 (Sub criteria)	Level 3 (Alternative)
The most suitable software development method for the institution	Personnel	1. Team distribution	Waterfall, Scrum, Rapid Application Development (RAD)
		2. Number of team members	
		3. Team skill	
		4. Team turnover	
	Process	5. Requirement changes	
		6. Requirement clarity	
		7. Evaluation in each phase or sprint	
		8. Software development category	
		9. Application development duration	
		10. Users learning process	
	Technology	11. Documentation	
		12. System testing	
		13. Technology availability	
	Organization	14. Communication	
		15. Cost	
		16. Client satisfaction	
		17. Number of projects per year	
		18. Policy	
		19. Project goals	
		20. Sourcing model	
		21. Risk management and after the implementation	

criteria, the expertise sub criteria is merged with the team skill sub criteria. The sub criteria formulation of the process criteria is described below:

1. The change management sub criteria is merged with the requirement changes sub criteria.
2. The phase evaluation, sprint changes, changes in sprint, user review meetings sub criteria are merged into the evaluation in each phase or sprint sub criteria.
3. The requirement clarity, requirement specification, and the initial stage requirement sub criteria are merged into requirement clarity sub criteria.
4. The development approach, discipline process, process time, iteration time, and the duration of testing are merged into application development duration.

The sub criteria formulation of the technology criteria is described below:

1. The bugs reporting, code review, early prototype, implementation file completeness and the design review are merge into the documentation sub criteria.
2. The acceptance test, scope testing, testing and testing preparation are merged into the system testing sub criteria.

3. The enterprise architecture sub criteria is merged with the technology availability sub criteria.

The sub criteria formulation of the organization criteria is described below:

1. The organization standard is merged with the organization culture into the communication sub criteria.
2. The beginning cost and the end cost are merged into the cost sub criteria.
3. The client satisfaction, customer interaction and the user involvement are merged as the client satisfaction sub criteria.
4. The internal policy, external policy are merged as the policy sub criteria.
5. The guarantee of success, maintainability, manageability and workflow are merged as the project goals sub criteria.
6. The risk involvement and the release management are merged as the risk management and after the implementation sub criteria.

The sub criteria are then evaluated based on the questionnaires results. The criteria, sub criteria, and alternatives variables are evaluated and then arranged to form an AHP structure, as
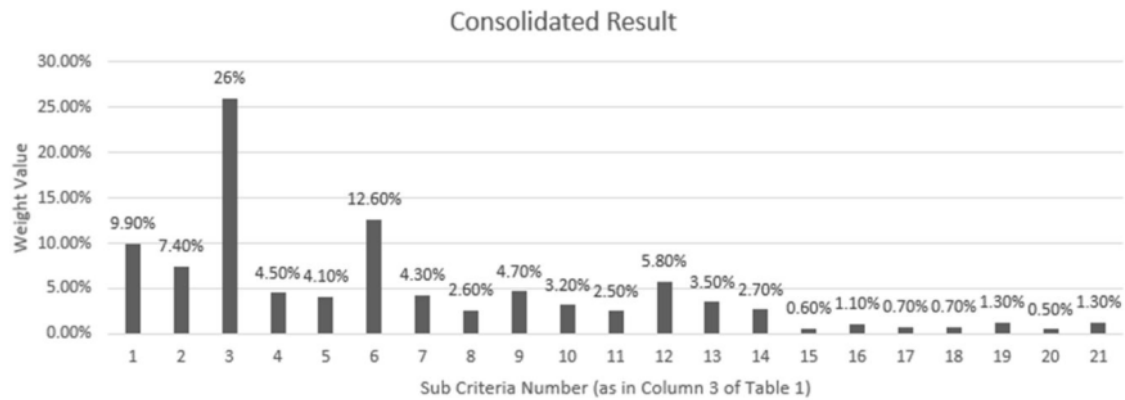
Figure 4. Sub Criteria Weight Presentation

provided in Table 1, as the base to conduct the pairwise comparison. The Level 0 is the goal of the research. The Level 1 shows the criteria, the Level 2 shows the sub criteria, while the Level 3 shows the alternatives. One of the alternatives would be the answer to the research question, as the most suitable software development method for the institution. Figure 4 depicts the weight representation of sub criteria.

5. DISCUSSIONS

According to the weighting results, it shows that Team Skills is placed in the highest rank with the weight of 26%, followed by Requirement clarity and Team Distribution with the weight of 12.60% and 9.90% consecutively. Whilst the least criteria is sourcing model with the weight of 0.6%.

Based on the results of this study, the most suitable software development method for the institution is the RAD method. The RAD together with the Scrum as the second priority method, could confirm the resulted priority criteria i.e. the team skill, as the both methods are dependent with the team skill. However, the RAD has some drawbacks, that it needs more team members. Nevertheless, project manager should put more efforts in monitoring the teamwork and in making decisions.

The unachieved project completion time problem in the institution could be overcome with the System Development Life Cycle (SDLC) of the RAD especially during its development and design stages which divide the development in several phases or versions or features implemented in parallel, to accelerate finish time of the project.

6. CONCLUSIONS

Based on the research results, this study draws some conclusions as follow:

1. The Rapid Application Development (RAD) is the most suitable software development method in the institution.
2. The top three methods obtained from the research are the RAD with the weight of 45.89%, followed by the Scrum with the weight of 34.03%, and waterfall with the weight of 20.04 %.
3. The team skill variable of the research sub criteria shows the highest priority with the weight of 26%.

The results lead to following suggestions for future research:

1. To work on the development of the software development standard procedure by adopting the RAD method.
2. To investigate the evaluation or assessment of the implementation of RAD in the institution's software development to determine its impact to the project time management.
3. To use or evaluate the AHP hierarchy structure proposed in this research in determining the most suitable software development method of the other organizations.

7. ACKNOWLEDGMENTS

8. REFERENCES

[1] Bernus, P. 2008. *International Handbook on Information Systems*. Springer.

[2] Creswell, J.W. 2013. *Research Design: Qualitative Quantitative Approaches, and Mixed Method Approaches*. SAGE Publications.

[3] Dennis, A. et al. 2015. *System Analysis & Design An Objected-Oriented Approach with UML*. John Wiley & Sons, Inc.

[4] Goretta, H. et al. 2018. Technology Criteria Analysis and E-Voting Adoption Factors in the 2019 Indonesian Presidential Election. *International Conference on Advanced Computer Science and Information Systems (ICACSIS)* (2018), 143–149.

[5] Guntur, M. et al. 2018. Critical Success Factors for Information Systems Development: A Case Study in E-Government. *International Conference on Business and Information Management (ICBIM)* (2018), 29–33.

[6] Hajrizi, E. and Bytyci, F. 2015. *Agile Software Development Process at Financial Institution in Kosovo*. IFAC-PapersOnLine 48-24.

[7] Helingo, M. et al. 2017. The Use of Analytic Hierarchy Process for Software Development Method Selection: A Perspective of e-Government in Indonesia. (2017), 405–414.

[8] Kahraman, C. 2008. *Fuzzy Multi-Criteria Decision Making*. Springer.

[9] Khan, M.A. et al. 2014. A Method for the Selection of Software Development Life Cycle Models using Analytic Hierarchy Process. *International Conference on Issues and*

Challenges in Intelligent Computing Techniques (ICICT) (2014), 534–540.

[10] Krejci, J. 2018. *Pairwise Comparison Matrices and their Fuzzy Extension Multi-Criteria Decision Making with a New Fuzzy Approach*. Springer International Publishing AG.

[11] Kumar, K. and Kumar, S. 2013. A Rule-Based Recommendation System for Selection of Software Development Life Cycle Models. *ACM SIGSOFT Software Engineering Notes2*. (2013), 1–5.

[12] Marchweka, J.T. 2015. *Information Technology Project Management: Providing Measurable Organizational Value*. John Wiley & Sons, Inc.

[13] Pressman, R.S. 2010. *Software engineering : A Practitioner's Approach*. McGraw-Hill.

[14] Riskiana, R.R. et al. 2017. The Use of Analytic Hierarchy Process to Rank Factors of Software Failures: A Case Study of a Telecommunication Company in Indonesia. *International Conference on Information Technology Systems and Innovation (ICITSI)* (2017), 336–341.

[15] Sagesser, K. et al. 2013. *Introducing an Iterative Life-Cycle Model at Credit Suisse IT Switzerland*. IEEE Computer Society.

[16] Sekaran, U. and Bougie, R. 2016. *Research Methods For Business: A Skill Building Approach*. John Wiley & Sons, Inc.

[17] Shah, U.S. 2016. *An Excursion to Software Development Life Cycle Models: an Old to Ever-growing Models*. CM SIGSOFT Software Engineering Notes.

[18] Sommerville, I. 2016. *Software Engineering*. Pearson Education Limited.

[19] Sulaiman, N.A. and Kassim, M. 2010. *An Approach Using RUP Test Discipline Process For Shared Banking Services (SBS) System*. Second International Conference on Computer Research and Development, {IEEE}.

Analysis software

1	www.icfme.org Internet Source	**6**%
2	Melisa Helingo, Betty Purwandari, Riri Satria, Iis Solichah. "The Use of Analytic Hierarchy Process for Software Development Method Selection: A Perspective of e-Government in Indonesia", Procedia Computer Science, 2017 Publication	**4**%
3	Florian Weissgerber, Eszter Lazar, Omid Tafreschi. "A balanced scorecard for holistic monitoring of shared services for corporate data protection", Proceedings of the 3rd International Conference on Business and Information Management - ICBIM '19, 2019 Publication	**4**%
4	Muhamad Guntur, Betty Purwandari, Teguh Raharjo, Iis Solichah, Larastri Kumaralalita. "Critical Success Factors for Information Systems Development", Proceedings of the 2nd International Conference on Business and Information Management, 2018 Publication	**1**%

5 muroran-it.repo.nii.ac.jp
Internet Source
1%

6 www.researchgate.net
Internet Source
1%

7 W Handayani, A S Ningrum, C Imawan. "The Role of pH in Synthesis Silver Nanoparticles Using Pometia pinnata (Matoa) Leaves Extract as Bioreductor", Journal of Physics: Conference Series, 2020
Publication
1%

8 Fahmi Alaydrus, Teguh Raharjo, Bob Hardian, Adi Prasetyo. "Approaches in Determining Software Development Methods for Organizations: A Systematic Literature Review", 2021 IEEE International IOT, Electronics and Mechatronics Conference (IEMTRONICS), 2021
Publication
1%

9 Teguh Raharjo, Betty Purwandari, Riri Satria, Iis Solichah. "Critical Success Factors for Project Management Office: An Insight from Indonesia", 2018 Third International Conference on Informatics and Computing (ICIC), 2018
Publication
<1%

10 eduglopedia.org
Internet Source
<1%

11 etheses.bham.ac.uk
Internet Source

<1 %

12 ejurnal.poliban.ac.id
Internet Source

<1 %

13 ieeexplore.ieee.org
Internet Source

<1 %

14 Hillary Goretta, Betty Purwandari, Larastri Kumaralalita, Oldyson Tri Anggoro. "Technology Criteria Analysis and E-Voting Adoption Factors in the 2019 Indonesian Presidential Election", 2018 International Conference on Advanced Computer Science and Information Systems (ICACSIS), 2018
Publication

<1 %

Exclude quotes	On	Exclude matches	< 3 words
Exclude bibliography	On		