Expected Characteristics and Features of a Decision-Making Framework for Infrastructure Project Selection: A Structured Thematic Analysis of Interview Data

Seng Hansen*, Eric Too and Tiendung Le
School of Property, Construction and Project Management, RMIT University, 124 La Trobe St., Melbourne, Australia
* E-mail: hansen.seng@rmit.edu.au

Abstract. As the largest economy in Southeast Asia, Indonesia faces various challenges in accelerating infrastructure development. One of these challenges is related to the selection of infrastructure projects that are increasingly stringent considering the continuing growth of infrastructure projects. This paper focuses on issues related to the development of a Decision-Making Framework (DMF) for infrastructure project selection. In order to develop a good DMF, expected characteristics and features must be understood. Thus, this paper aims to identify these expected DMF characteristics and features through a qualitative approach. Twenty semi-structured expert interviews were conducted and analysed based on a structured thematic analysis to identify four key DMF characteristics and three groups of DMF features. These identifications are an important effort in developing a DMF so that it can be fully utilized and well-functioned. Finally, this paper reflects the current expectations in developing a good DMF for infrastructure project selection.

1. Introduction

Infrastructure development plays a crucial role as the driver of economic growth in Indonesia, the largest economy in Southeast Asia. The Indonesian government has realized this fact by heavily invested in infrastructure projects as government’s top priority. However, it has become a challenge to invest in the right projects, especially with previous experiences where infrastructure projects were cancelled or abandoned. On the other hand, not all infrastructure project proposals can be approved considering the limited investment resources. Thus, the government may want to develop an efficient Decision-Making Framework (DMF) to appropriately select and prioritize infrastructure project proposals. A poor project selection will lead to the approval of wrong project proposals to be executed, while a good selection will produce a list of project priority which will eventually increase project success rate, decrease project overruns, and decrease project cancellation rate.

This paper focuses on identifying the expected characteristics and features of a good DMF for infrastructure project selection. These identifications are crucial since the selection and prioritization process of infrastructure projects is still a major decision-making problem in Indonesia. It can be regarded as an initial step before developing an actual DMF to be implemented for selecting and prioritizing infrastructure projects. By identifying these expectations would allow more effective and efficient DMF as a decision-making tool. This objective is crucial since there has been no previous research on the identification of expected DMF characteristics and features in Indonesian context. Following a brief review of literature, this paper presents a systematic qualitative method to collect and analyse the interview data. The data were mainly collected from three different ministries in Indonesia.
The results were discussed in details consisting of two main findings, i.e. the expected DMF characteristics and the expected DMF features. Finally, several limitations and further studies were presented.

2. Sustainable Infrastructure Practice through Project Selection and Prioritization

Infrastructure development should follow sustainable principles which highlight the importance of the social, economic and ecological aspects in maintaining human equity and healthy ecosystem. One way to achieve these principles is by developing an efficient infrastructure project selection and prioritization process. This selection process is part of infrastructure planning that must get enough attention to ensure that available resources are provided to the most appropriate projects. It occurs during the Front-End Planning (FEP) phase which defines as the process of developing sufficient strategic information with which the decision makers can decide to commit resources [1].

Considering the importance of this selection process, this research seeks to identify expected characteristics and features when developing a DMF for infrastructure project selection. According to Nnaji et al. [2], a DMF is a vital managerial tool that used to assist decision makers in making an objective decision. In this research context, DMF refers to a framework or system used to ensure that the selection and prioritization process of infrastructure projects has been well conducted. To develop such framework, expected characteristics and features should be identified so that it may provide an effective framework to be implemented.

3. Method

A qualitative approach was adopted in this study where twenty semi-structured expert interviews were conducted to obtain insights from expert respondents. The interview process consisted of eight systematic steps as follows.

(1) Developing interview draft

It is the most crucial step which involves interview questions development and interview protocol design. Appropriate interview questions can be developed through critical review of previous literature. Here, the authors have developed a list of interview questions in a matrix form as shown in Table 1 below. Meanwhile, interview protocol is helpful in assisting the authors when conducting the actual interviews. The protocol consisted of four parts, i.e. introduction, questions related to interviewee’s background, questions related to interview topic, and interview closing.

| No | Interview Questions                                                                 | References |
|----|-------------------------------------------------------------------------------------|------------|
| 1  | How do you make decisions related to infrastructure project selection? / What is your current practice in making decisions related to infrastructure project selection & prioritization? | [4, 5, 6] |
| 2  | How should the DMF be developed? / What are the expected characteristics?             | [2, 7]     |
| 3  | What are the features that must be available in a good DMF for infrastructure project selection? | [8, 9]     |

(2) Conducting pilot interview

A pilot interview was conducted to ensure that the questions and protocol are clear, concise, and appropriate. It is also useful for the authors to understand the possible interview situation and thus, develop necessary skills in conducting the actual interviews.

(3) Determining interview size and target respondents

As qualitative research, interview sample size mainly depends on data saturation which characterised by the occurrence of commonalities in responses provided by interviewees. Here, a large sample size of twenty interviews has been collected from four groups of experts, i.e. the
Ministry of Public Works & Housing (MPWH), the Ministry of Transportation (MT), the Ministry of National Development Planning (MNDP), and the academics. These experts should meet the following criteria: (1) professionals working at the relevant ministries or consultant agencies, (2) having a construction-related educational background, and (3) having experience in infrastructure project planning and/or selection.

(4) Conducting interviews
Twenty actual interviews were conducted from December 2018 to March 2019. The average interview duration was 48.45 minutes with a total experience of 272.6 years. With permissions, the interviews were recorded using a voice recorder.

(5) Transcribing interview data
Interview records were transferred to a computer in audio files which then transcribed into written transcripts. These transcripts were still in the original language of Bahasa Indonesia.

(6) Translating interview data
All written transcripts were then translated into English for further analysis. These translations were then exported to NVivo 12 Pro software.

(7) Analysing interview data
A structured thematic analysis was conducted to analyse the data. According to Braun and Clarke [3], thematic analysis consists of six phases of familiarization, initial coding, themes development, themes review, themes naming, and findings identification. In this analysis, coding is the most crucial phase used to generate a list of phenomena which has implications for the research objectives.

(8) Reporting findings
All findings were discussed and reported in this paper.

4. Results and Discussion
Based on the analysis, the observed phenomena can be grouped into two main issues:
1. The expected characteristics of DMF for infrastructure project selection
2. The expected features of DMF for infrastructure project selection

4.1. The Expected Characteristics of DMF for Infrastructure Project Selection
First issue is related to the expected DMF characteristics. This refers to the expected qualities of the proposed DMF. The analysis has identified four DMF characteristics which are expected to improve the performance of DMF for infrastructure project selection and prioritization, namely: user friendly, transparency, accountability, and technology based. Similar characteristics can also be found in other DMF developments [8, 10, 11].

The first characteristic is user friendly where the DMF to be developed is expected to be easily understood and used by decision makers. This was conveyed by R-18 as follows:
[The DMF should be] Easy to be understood, easy to be implemented by the operators maybe, easy to be operated.
This user-friendly characteristic has several attributes including:
(1) Straightforward and clear process
The process and procedure for selection and prioritization of infrastructure projects must be clear and straightforward. The DMF interface should not be complex as well.
(2) Detailed enough
The process of selecting infrastructure projects should be detailed enough and includes all important points so that users easily understand the intent of each point or process.
(3) Simple and small indicators
The selection criteria contained in the DMF are small and simple so they are easy to be understood and use.
Figure 1. Identified DMF Characteristics and Features.

By developing a user friendly DMF, it aims to provide a good user experience. In addition, user friendly DMF will also facilitate the introduction and implementation of DMF to FEP teams or decision makers so as to minimize the potential for DMF rejection.

The second characteristic is accountability. In this study context, it refers to the responsibility of the parties involved in decision-making process for infrastructure project selection. This is important considering the process of selecting and prioritizing infrastructure projects using public funds and involving many parties. Therefore, clarity about who and how accountability is carried out needs to be stated in DMF documents. There are at least two elements of accountability that need to be highlighted:

1. **Answerability**
   In the decision-making process, decision makers must be able to answer why the decision is taken. R-17 said:
   *Accountable as well. For example, province A got this much budget. Now we should be able to answer it why.*
   This can be done by providing information and justification regarding the outcome of the decision.

2. **Enforcement**
   The results of the selection decision must be able to be enforced, meaning that all parties being subject to, accept and execute the results of the decision.

The third characteristic is transparency which will enable accountability as well. In the context of this research, transparency refers to the situation where the decision makers are transparent to other people on how they arrive at their decisions. The importance of transparency was conveyed by several respondents including R-12 as follows:
Transparency is needed in carrying out prioritization activities. Transparency here means transparency in the process and transparency in terms of data or information. ... Awareness of the importance of transparency in each process will play an important role in supporting the prioritization of infrastructure projects to be effective and efficient.

However, this does not mean all data and information should be made publicly available because some types of data and information are confidential. The most important thing that should be made publicly available is the procedure for selecting and prioritizing infrastructure projects are correct and clear. Thus, having a DMF is crucial as a mean to provide transparency.

The last characteristic is technology based. Considering the current technological developments, it is expected that the DMF for infrastructure project selection and prioritization can also utilize the application of technology. Some forms of technology utilization in the process of selecting and prioritizing infrastructure projects may include:

- Developing a DMF for infrastructure project selection that provides a DM tool based on proven MCDM (Multi-Criteria Decision-Making) techniques
- Developing a system for online data collection, e.g. submitting infrastructure project proposals online
- Developing a DMF for infrastructure project selection in the form of software application

4.2. The Expected Features of DMF for Infrastructure Project Selection

In the context of this study, features refer to the important parts of the DMF for infrastructure project selection. These features must be available in a DMF so that the decision-making process can effectively run and provide optimal results. Thus, identifying features is essential in the development of DMF for infrastructure project selection. The results of the analysis has identified three categories of DMF features, namely: introductory features, selection features, and complementary features.

Introductory features refer to important features in the introduction part of the DMF. As an introduction part, these features aim to explain at least four aspects, namely: definition of DMF, importance of DMF, who are the stakeholders involved, and who are the beneficiaries of this DMF decision.

The definition of DMF is important to convey in the DMF or DMT document so that users understand the intent and purpose of providing the DMF. In this study, DMF is interpreted as a structured and systematic approach to problem solving and decision-making in complex situations that serve as a guide for decision makers in achieving their organizational objectives and goals. It covers several aspects that help the process of selecting and prioritizing infrastructure projects, including selection stages and selection criteria.

In addition to defining DMF, it is crucial to emphasize the importance of DMF for infrastructure project selection and prioritization. DMF is needed to bridge the effective decision-making process between multiple decision makers involved in infrastructure project planning and selection. It is a vital managerial tool used to select and prioritize various infrastructure project proposals. By using DMF, decision makers will be easier to reach a high-quality decision, i.e. which projects are selected and prioritized. Without the presence of DMF, the selection process will not be easily measured and carried out so that the risk of making the wrong decision is higher (inappropriate project selection which leads to inappropriate budget allocation). In fact, all respondents who were asked stated that it is important to have DMF for infrastructure project selection and prioritization.

The stakeholders involved also need to be explained in the introduction part. In the process of selecting infrastructure projects in Indonesia, the key stakeholder is the central government consisting of strategic ministries such as MPWH and MT. In addition, the selection process can also involve local governments, funding agencies, public communities, and private sector interested in investing in infrastructure development. Considering the process of selecting and prioritizing infrastructure projects involves many parties, the DMF must identify who the stakeholders can be involved in and the extent to which they are involved in each stage of selection and prioritization process.
Finally, beneficiaries from the results of the decision on the selection of infrastructure projects also need to be delivered. As a DMF that aims to select and prioritize infrastructure projects, the beneficiary in general is the public community, as well as the private sector. This is important to emphasize especially for infrastructure projects that use public funds.

Next, there are selection features which refer to key features that must be available in the DMF. There are at least four key features included in the selection features, namely: selection stages & decision points, Decision-Making Tool (DMT), timing & procedure, and funding schemes.

Selection stages & decision points are important features in the selection process. In the context of this study, selection is interpreted as the process of sorting and selecting the right infrastructure project proposals that meet the requirements for funding and execution. This process also includes the stages of prioritization. In practice, there are various selection stages to adjust the needs of the organization. For example, R-11 proposed a selection process in DMF consisting of two stages, namely: economic assessment followed by financial assessment. While R-19 proposed two stages of selection in the form of stage 1 (needs assessment) and stage 2 (further studies).

However, all of these selection processes have a systematic procedure for selecting and prioritizing alternatives so that a selection decision can be made. To simplify the process, a decision points or decision gates are provided at the end of each stage during the selection process.

Another important feature in the selection process is the Decision-Making Tool (DMT). This feature is the most frequently mentioned by respondents including R-7, R-12 and R-19. It is used to assist decision makers in making decisions based on an established systematic selection procedure. Although it usually employs quantitative techniques, DMT can also be developed using qualitative techniques (such as decision trees, expert judgment, and delphi techniques). In the context of this study, DMT will be developed using a quantitative approach based on the Multi-Criteria Decision-Making (MCDM) techniques such as AHP, NSFDSS, and Electre. This is because in the process of selection and prioritization of infrastructure projects involved many stakeholders to assess various project proposals against multiple criteria. Thus, there are two aspects that must be addressed in the DMT, i.e. which MCDM technique to be employed and what are the selection criteria to be used.

Furthermore, other features that must be available are timing and selection procedures. This feature is important to ensure that the mechanism for selecting and prioritizing infrastructure projects can run smoothly. In practice, all decision-making processes will require clear timing and procedures. This was also expressed by R-13 as follows:

*In the framework, of course it must be clear when the proposal period and when the approval is made, ...*

The duration of decision-making that is too short can cause the process to be reckless while the duration that is too long can cause delays in decision making and loss of momentum. This will eventually lead to poor decisions. To determine the right duration of decision-making process for infrastructure project selection will depend on three things:

1. **Availability of information**
   "The amount of data and information available to be processed before a decision is made affects the duration of decision-making process."

2. **Availability of time resources**
   "The amount of time available to make a decision-making process also affects the quality of the decision. Time pressure factor (the presence of deadlines) can cause decision makers make decisions in a hurry. Likewise, if time resources are too long does not necessarily produce better decisions."

3. **Clarity of selection procedures**
   "Clarity of selection procedures can also affect the decision-making process. Internal procedures for selecting and prioritizing infrastructure projects must be established to ensure that the process flow runs smoothly."

Finally, the selection features also include funding schemes. It refers to options to finance a project. This is related to the selection and prioritization process where different selection weights can occur in
different funding schemes such as fully funded from state budget, PPP, or private sector. This was conveyed by R-4 as follows:

Yes, so can it be funded using available budget, whether it will be fully funded from national budget, or by PPP, partnership between government and private company, or can it be fully funded by the private company.

The last category in DMF features is complementary features. It refers to features that complement the two previous features in the DMF for infrastructure project selection. With these complementary features, DMF's performance will be better and make it more whole in assisting decision makers to make high quality decisions. In other words, these features make DMF more complete.

Having an audit process is an important feature as a complement in DMF. Although this feature is not directly related to the selection and prioritization process of infrastructure projects, it is useful to ensure that all the processes and selection procedures in DMF have been properly and correctly carried out by its users. This is similar to what was conveyed by R-1:

Actually, in my opinion, the audit process is necessary to ensure that the entire framework is implemented well, that all parties are indeed involved and know how.

This audit process covers all stages of the selection and prioritization of infrastructure projects starting from the beginning until a decision is made regarding the list of priority projects. It can be carried out by a special team that handles the audit process.

Next, clear coordination and communication must also be established in DMF. This is due to the large number of stakeholders involved in the selection and prioritization process so that synchronization of different responsibilities and interests is needed. Both are key management processes in decision-making practice. Identification of stakeholder involvement at each stage of infrastructure project selection is critical. In this case, good coordination arises from good communication. The importance of understanding this feature was conveyed by several respondents, one of which was R-15 as follows:

The feature maybe the involvement of all elements. So, the communication between ministries, departments must exist. So far, it is like fragmented. I think it is important.

Another complementary feature that must be available in the DMF according to some respondents is regulatory. This feature has two aspects. First, that the entire process of selection and prioritization of infrastructure projects as contained in the DMF must be in accordance with applicable laws and regulations. Here, DMF for infrastructure project selection must be made by considering other existing regulations related to infrastructure development in Indonesia. This was stated by R-19 as follows:

It should be opened and in accordance with the applicable regulations.

While the second aspect of regulatory feature is that DMF for infrastructure project selection must be a standard practice and becomes a guideline for planning infrastructure development which is also authorized as part of regulation. Until now, there has been no standard DMF for infrastructure project selection in Indonesia. Each ministry, department and agency have their own procedures for selecting infrastructure projects that are not necessarily through the correct DMF establishment and development process. By becoming part of regulation, DMF for infrastructure project selection can bind the involved stakeholders to utilize and standardize their selection and prioritization methods in order to increase the efficiency of the decision-making process and provide high quality decisions.

The last complementary feature is visualization. Visualization is an important technique to present data and information to users in order to be easily understood. In the context of this research, data visualization will help decision makers in selecting and prioritizing infrastructure projects while decision visualization will help stakeholders understand the results of the selection process. R-9 argued:
The feature that I think is important is how this planning can be visualized. Usually these people, our people in my opinion will understand better something that is shown visually.

Although visualization is often displayed in graphical display of data or information, the purpose of providing visualization is to gain insights from the information displayed. Visualization is a feature to help decision makers make decisions efficiently because when data is properly visualized, they become easier to read and understand. Thus, there are several benefits of this feature:

- Visualization can bridge the gap between data and insights, for example: what types of infrastructure projects are highly dependent on land acquisition?
- Visualization can establish patterns and relationships, for example: why do water management related infrastructure projects receive smaller budget approval than transport infrastructure projects?
- Visualization can predict trends, for example: annual trend of funding schemes for infrastructure projects

From the above analysis, perhaps the most important feature is selection features which consists of selection stages and procedures, DMT, and funding schemes. Selection process itself is a lengthy and complex process as it involves a series of systematic steps. These steps can be further developed into several selection stages. It may vary from one organization to another. For example, the CDIA [9] framework has three stages, i.e. financial capacity analysis, project prioritization, and project programming for investment. Meanwhile, DMT as an important part of DMF is used as means to select and prioritize infrastructure projects. Utilizing DMT shows that decision makers implement a rational selection technique rather than judgmental selection technique. One way of assessing DMT is by scoring method based on multiple weighted criteria.

5. Conclusions

The increasing demand for sustainable infrastructure projects have required the need to develop a good DMF for infrastructure project selection. In an effort to develop an effective DMF, expected DMF characteristics and features must be identified. Using a structured thematic analysis of interview data, this research has successfully identified four key DMF characteristics and three groups of DMF features. These identifications are an important effort in developing a DMF so that it can be fully utilized and well-functioned. In conclusion, this paper reflects the current expectations of expert respondents for an effective DMF for infrastructure project selection.

Finally, there is a limitation from the investigation that have been carried out. This study examines decision-making process for infrastructure project selection as conducted in three ministries as an executive part of governance in Indonesia. On the other hand, this study does not directly study the process of decision-making by the legislature (the DPR/Dewan Perwakilan Rakyat) which also has a role in the selection process (commonly known as the post technocratic process). Thus, the DMF for infrastructure project selection that will be developed only functions within the scope of technocratic processes (before entering the stage of selection and approval by the DPR).

Further studies may focus on the development of DMF for infrastructure project selection. Since infrastructure projects involve multiple variables, this DMF should be developed based on a MCDM technique such as AHP and NSFDS-III. Thus, establishment of selection criteria becomes crucial as evaluation parameters to assess the project proposals.

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