# Novel Approach to Satisfy Stakeholders in Megaprojects: Balancing Mutual Values

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## Abstract

Stakeholder satisfaction in megaprojects has always been a critical concern in research and practice due to the dynamism, complexity, and uncertainty of the various relationships between the project and the stakeholder community. The most successful outcome for a megaproject would be achieved when it creates values fairly for stakeholder community to satisfy them. Therefore, due to the resource constraints, megaproject should create values for stakeholders proportional to the values that they put into it. This article proposes a framework for priority-setting in stakeholder engagement based on the balance of mutual value creation between the megaproject and stakeholder community. In this way, we developed an innovative and systematic approach by drawing on "stakeholder theory", "value creation theory", "expectation disconfirmation theory", and "fuzzy set theory" while adopting from Data Envelopment Analysis (DEA) concepts. This study contributes to the theory and practice of engineering management by examining stakeholder engagement to satisfy them fairly in megaprojects. Particularly, this study categorises stakeholders based on the proportional of their salience to expectations to three main types: "Modest", "Fair" and "Demanding". This typology will provide a road map for managers to prioritise the responses to stakeholders' expectations. Finally, we applied the proposed approach for a real-case of mega construction project (MCP).

*Keywords*: Stakeholder Satisfaction, Stakeholder Engagement, Stakeholder Management, Stakeholder Salience, Stakeholder Expectation, Value Creation, Mutual Values, Megaproject, DEA.

## Introduction

Megaprojects are a type of project with large investment and high scales in other aspect that attract the attention of various social and political groups (Van Marrewijk et al. 2008, Mok et al. 2015, Ma et al. 2017, Li et al. 2019). These projects are extremely dynamic and complex, and involve many stakeholders that can impact or be impacted by it (Bosch-Rekveldt et al. 2011, Feige et al. 2011,

Sanderson 2012, Flyvbjerg 2014, Chan and Oppong 2017, PMI 2017). Therefore, project managers should pay enough attention to stakeholders' expectations to engage with them successfully (Widén et al. 2013, Park et al. 2017, Xia et al. 2017, Bishop et al. 2018). Since every stakeholder may have abundant and diverse expectations, managers must fulfil their expectations in a proper manner and at the right time. However, due to resource constraints, such as cost and time, managers cannot fulfil all stakeholders' expectations (Pheng 2018). Therefore, they should try to look for the highest possible stakeholder satisfaction through a systematic approach. Automation and integration technology can contribute significantly to project performance in terms of stakeholder success and satisfaction (Yang et al. 2007, Succar 2009, Sun and Zhang 2014, Pargar et al. 2019). As a result, it can play a key role for successful management in engineering.

So far, a few studies have been conducted on managing stakeholder engagement in various kinds of megaprojects. For example, Zhai et al. (2009) explored the value of project management from the stakeholders' perspective, creating a value framework for mega construction projects (MCPs). Li et al. (2013) provided a framework for systematically evaluating the effectiveness of public participation through the measurement of stakeholder satisfaction. Yang et al. (2018) have explored the evolution of stakeholder analysis and engagement practices adopted in Australian megaprojects over the last two decades. Other researchers have studied stakeholder management and engagement from the lens of network analysis (Fang et al. 2012, Yang and Zou 2014, He et al. 2015, Matinheikki et al. 2016, Mok et al. 2016, Zheng et al. 2016, Wang et al. 2017, Laursen 2018, Luo et al. 2018). Although stakeholder network analysis can provide a good overview for managers by illustrating stakeholders and their dimensions of impact and expectations, it does not focus on decision-making based on the balance between mutual value creation. While it is inferred from project management literature, mutual value creation is critical to the achievement of success (PMI 2017).

In various stages of a megaprojects' life cycle, priority and degree of engagement with those who have low salience and high expectations should not be similar to ones who have high salience and low expectations. A project management team can both create value for the megaproject and satisfy the stakeholders in an optimal way when they fulfil the stakeholders' expectations based on their salience. In this situation, stakeholder engagement will be based on mutual value creation. Therefore, a critical gap in previous studies is the lack of a centralised effort to 'pay more attention to the expectations of more efficient stakeholders'. Another gap in previous research is the lack of a tool that investigates stakeholders' overall relativity. Existing tools have usually analysed stakeholders individually in accordance with their specific characteristics (e.g. Park et al. (2017); Flyvbjerg (2014); Karlsen (2002), etc.). In order to fill the aforementioned gaps, it is essential to use an approach that helps to plan stakeholder engagement based on mutual value creation. Therefore, stakeholder engagement based on balanced mutual value creation between megaproject and stakeholders is critical for success (Bourne 2011, Eskerod and Huemann 2013). A mutually beneficial engagement enhances the ability for both the project and the stakeholders to create value for each other (Oliomogbe and Smith 2013, PMI 2017). Therefore, two prerequisites are needed to make decisions about stakeholders' engagement in megaprojects. The first prerequisite is awareness of their level of salience (Yang 2010), which reflects their value for the project (Schibi 2013). The second prerequisite is awareness of the level of their expectations, which arise from their interests, goals, tendencies, beliefs, and agreements or disagreements in the project (Nevo and Chan 2007, Hitzeroth and Megerle 2013, Palawatta 2015, Braddock and Dillard 2016).

The purpose of this article is to present a framework to typologise the stakeholders and establish priority-setting in stakeholder engagement based on mutual value creation between the megaproject and stakeholders. To test the framework, we studied the implementation phase of the national mega-construction project of Mashhad Urban Railway (Line 2). This project includes a deep tunnel with a 14.5-km route and 13 stations. The project had a budget of 2,320 billion Iranian riyals. This project was purposely selected for its expected capacity to provide information and to test the theoretical framework. The rest of this article is structured as follows. In the next two sections, we present the literature and the theoretical framework for the study. In the subsequent section, we present the case and findings

from the data collection and the data analysis. Then, we discuss our findings. In the final section, we draw the conclusion, highlight the main implications, and point at future research.

## Literature Review

### Stakeholder concept

The concept of *stakeholders* was introduced by Stanford Research Institute in 1963 (Koschmann and Kopczynski 2017). Freeman (1983), Mitchell et al. (1997), and Eskerod et al. (2015) defined stakeholders as "individuals or groups that affect or are affected by the process, content, or outputs of a project". In recent decades many empirical studies have been conducted on stakeholder theory and concepts, particularly stakeholder typology and management (Karlsen 2008, Van der Laan et al. 2008, Parmar et al. 2010, Miles 2015). Windsor (2017) states that stakeholder research is also being linked to theories in business management such as value creation theory. According to value creation theory, the project business will be successful in short- and long-term, if the value creation is mutually beneficial for the project business and all stakeholders (Eid and El-Adaway 2016). The values can be of both physical and cognition-based nature. In other words, value creation and stakeholders' satisfaction depend on considering both the performance and perception streams flowing between the project and stakeholders. Therefore, value creation for and with stakeholders requires both a joint purpose and stakeholders' active contributions (Freudenreich et al. 2019).

### Stakeholder engagement

Stakeholder engagement is the process of communicating with, involving, and developing relationships with stakeholders in order to achieve ideal values (Greenwood 2007, Chinyio and Akintoye 2008). Deegan and Parkin (2011) identified two levels of stakeholder engagement: (1) involvement as a means of 'information giving and consultation' to increase stakeholders' knowledge of a project; and (2) participation as a higher level of engagement by reducing stakeholder resistance to a project. Generally, managing stakeholders' engagement is a process in which managers are trying to communicate with, inform, and involve stakeholders to fulfil their expectations, reduce conflicts, and establish clear project priorities (Deegan and Parkin 2011, Leung et al. 2013, Mok et al. 2015, Park et al. 2017, Valentin et al. 2018). The ultimate goal of stakeholder engagement is to achieve project values and the stakeholders' maximum possible satisfaction during its life cycle. In order to achieve this aim, it is necessary for managers to have a precise engagement plan. This plan should be structured according to project needs and stakeholder expectations.

### Value creation

Value-based management points out that the systems, processes, and individuals in a business unit, should be driven towards creating values and these systems should be oriented towards value creation (Meyer 1992, Young et al. 2000, Hoque et al. 2004). The concept of 'value' has so far been used in various disciplines, from psychology to project management science (Schwartz 2006, Zhang and El-Gohary 2015). As a simple general definition, values are 'things that are important throughout human life' (Schwartz 2006, Heisler 2017). Therefore, in the relationship between the project and the stakeholders, *values* are defined as features that are important for both the project and the stakeholders. Nowadays, the value paradigm in project management has shifted from 'managing and engineering values' to ideas of 'understanding how stakeholders value different things'. Therefore, one of the prerequisites to interact with stakeholders is to understand their perceptions (Cheng and Fleischmann 2010, Zhang and El-Gohary 2015).

Value creation for each stakeholder needs to be balanced by what the project management will gain in return, or the value it will extract from the relationship. The managers should determine what they are seeking from each stakeholder group (Springman 2011). In general, the impact of stakeholders on the project determines their value creation for the project, and the impact of the project on the stakeholders indicates its value creation for the stakeholders. Project management team and project managers should specify and compare 'value for who, value by whom'.

## Stakeholder salience

Stakeholder salience indicates the degree that would affect managers' decisions for prioritising stakeholders' competing claims and demands (Mitchell et al. 2011, Neville et al. 2011, Erdiaw-Kwasie et al. 2015), and depends on the managers' perceptions thereof. Therefore, the most important prerequisite for determining stakeholders' salience is recognition and realistic understanding of their salience attributes (Mitchell et al. 2011, De Oliveira Neto et al. 2015, Järlström et al. 2016). Due to the dynamism of the megaproject environment, these attributes are changing over time; therefore, managers should identify and then update stakeholders' salience (Chan and Oppong 2017, PMI 2017). So far, some researchers have introduced specific salience attributes to indicate stakeholders' importance and value for the project. In one of the most important studies, Mitchell et al. (1997) introduced 'power, legitimacy and urgency' as stakeholder salience attributes. Accordingly, power is the potential for influence through knowledge, economics, physical force, and political processes. Legitimacy is defined as the value that indicates the suitability of the stakeholder's action patterns with contracts, legacies, and the rules governing society. Urgency is defined as the degree to which a stakeholder's claim calls for immediate attention because of its time-sensitive nature and its importance to the stakeholder.

## Stakeholder expectation

Expectation Disconfirmation Theory (EDT) is a well-known cognitive theory that seeks to explain the stakeholder (customer) satisfaction as a function of expectations, perceived performance, and disconfirmation of beliefs (Petter 2008). The main structure of the theory was developed in a series of two articles written by Oliver (1977) and Oliver (1980). Although EDT has originally appeared in the psychology and marketing literatures, it can be adopted in several other scientific fields, notably project stakeholder management and engagement. According to EDT, stakeholder expectations are present- and future-oriented and relatively malleable beliefs about the likelihood that short- and long-term outputs are associated with certain attributes, benefits, or outcomes that lead to the achievement of stakeholders' values (Karimi et al. 2015, Souza et al. 2015, Zimbardo and Boyd 2015). From a value-based perspective, stakeholders' expectations represent their expected values viewed through a lens based on the performance, output, and delivery of megaprojects. Stakeholder expectations arise from the objectives of their participation in the project or its outputs. Therefore, by knowing the reasons for and objectives of stakeholder participation, a significant part of their expectations can be divined (Olaverri-Monreal and Goncalves 2014, PMI 2017). For successful stakeholder engagement, it is very important for managers to have a plan that clarifies stakeholder expectations (Bahadorestani et al. 2018). On one hand, the more project managers can benefit from stakeholders' salience in line of project progress at a right time, the more value will be achieved for the project; on the other hand, the higher the stakeholders' expectations are, the more value they will demand from the project (Kirjola 2011). Therefore, the stakes that stakeholders have in project endeavours should be framed by their expectations in line with salience attributes (Chan and Oppong 2017).

## A framework for balancing value creation between the project and stakeholders

### Stakeholder engagement models

It is inferred from EDT that managers can look at phenomena from a more precise lens rather than a materialistic perspective. Therefore, they can go beyond the magnitude of materialism that only considers physical value streams such as money flow between the stakeholders and projects. Because it is a more precise lens that develops the previous insights while considering the physical value streams too. Since EDT is a cognitive theory in which both perception and performance are considered for stakeholder satisfaction, two value streams with the comprehensive sense of both physical and non-physical values are identifiable. The first value stream is stakeholder salience, and the other is stakeholder expectations, as illustrated in Figure 1.
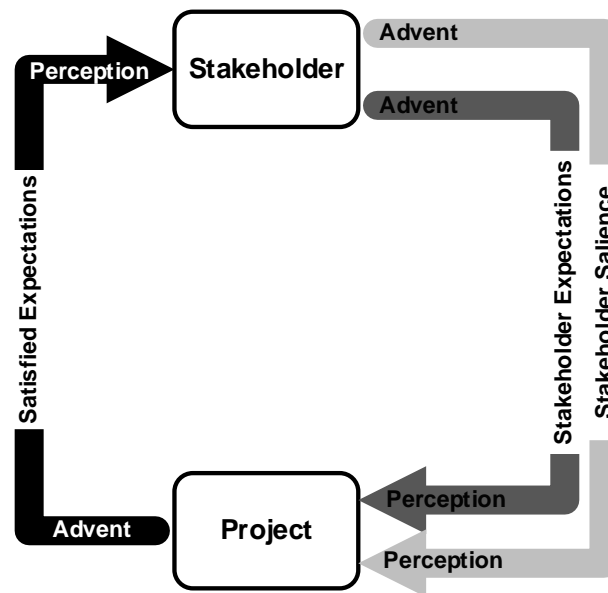
**Figure 1. The streams of values between stakeholders and project**

In Figure 2, we introduce stakeholder engagement perspectives in the form of a continuous spectrum. This spectrum depicts how the managers set their lens to engage with stakeholders. In other words, they engage with stakeholders in accordance with this spectrum either intentionally or unintentionally. At the right end of the spectrum, the project attention is towards stakeholders' salience, named 'salience-based engagement model (SBEM)'. At the left end of the spectrum, the project's attention is towards stakeholder expectations, described as 'expectation-based engagement model (EBEM)'. In the middle of this spectrum, we can find a point where stakeholder engagement is based on balancing between stakeholder salience and expectations, described as 'balanced engagement model (BEM)'.

In the SBEM, engagement is based on the values that stakeholders have created for the project. Therefore, managers will prioritise them according to the level of their importance or salience. The right end of the spectrum in Figure 2 shows stakeholder engagement in which the project perceives stakeholder salience and engages with stakeholders accordingly.

In the EBEM, engaging with stakeholders is based on their expectations. In this model, managers prioritise their engagement based on the level of stakeholder expectations. Therefore, the criterion for decision making by managers is the level of stakeholder expectations. Therefore, stakeholders who have fewer dimensions of expectations or a lower level of expectations will be priority, because they need fewer resources to fulfil their expectations. For example, in the stakeholder community, if stakeholder *A* has an expectation in the cost dimension, but another stakeholder has expectations in the cost, quality, and time dimensions, stakeholder *A* will be the priority because this stakeholder requires fewer project resources to be satisfied. The left end of the spectrum in Figure 2 shows EBEM in which managers will merely consider expectations to satisfy stakeholders.
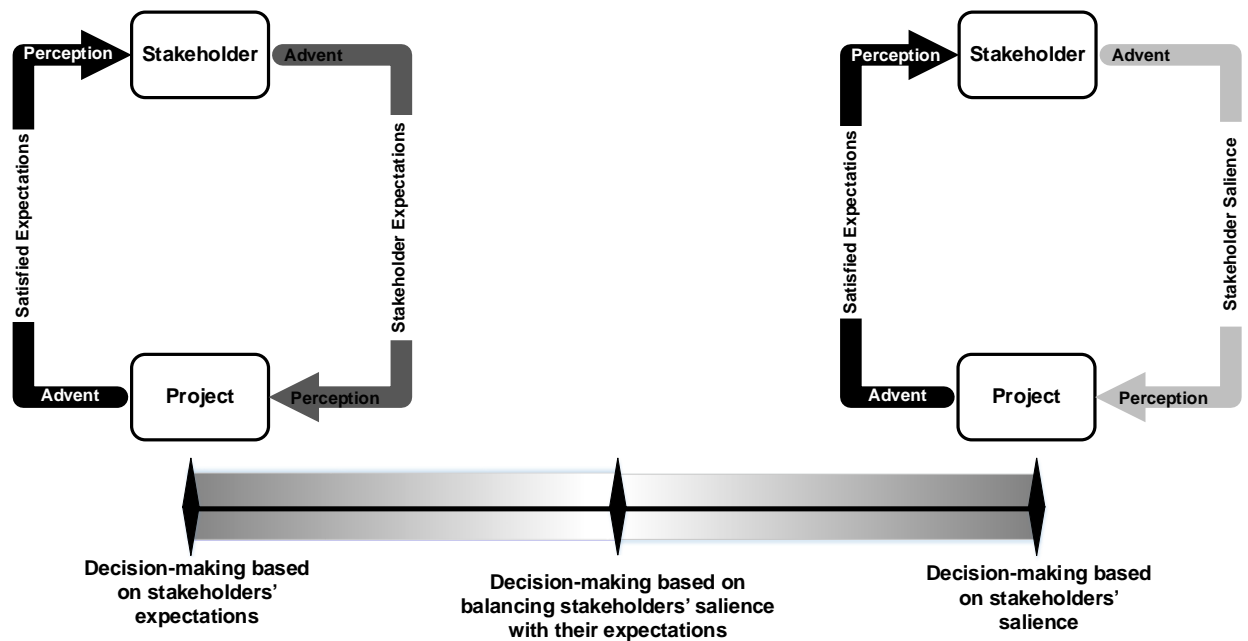
**Figure 2. Various perspectives to stakeholder engagement**

In the unbalanced engagement model the value streams that flow from the stakeholders toward the project are not equal, value streams from the project toward stakeholders. Accordingly, both salience-based engagement and expectation-based engagement are unbalanced engagement.

In the BEM when the project captures high values from a stakeholder, it will satisfy stakeholder expectations more completely. Conversely, when it captures low values, it will satisfy stakeholder expectations poorly. The project will progress and the qualified stakeholders will be satisfied as soon as possible when managers balance mutual value creation (Freudenreich et al. 2019). In order to balance mutual value creation, the higher a stakeholder's salience, the more complete attention their expectations should be paid (BEM).

Managers have limited and pre-determined resources to allocate in satisfying the stakeholder community's expectations. If resource consumption is such that the stakeholders with more salience and less expectations are in priority, then the project has optimised resource consumption. On the one hand, this stakeholder will be satisfied with lower resources due to the lower level of expectations, and on the other, the stakeholder will create more value for the project due to their level of salience. Indeed, balanced engagement is a developed insight that addresses both the stakeholder salience and expectations (middle of the spectrum in Figure 2).

If the project is to achieve its goals and succeed, managers must try to balance the streams of stakeholder salience and expectations with an appropriate engagement tool to prioritise stakeholders (Eskerod and Huemann 2013, Silvius 2017). As a result, in the stakeholder engagement model, if there is a balance between stakeholder salience and expectations, the project will progress towards its goals as best as possible. Otherwise, managers should balance it by changing resource allocation to stakeholders.

**Stakeholder typology in the BEM**
If the stakeholder engagement approach is chosen based on the BEM, the project will encounter three types of stakeholders. Figure 3 shows these three types of stakeholders: 1) The stakeholder whose level of salience equals the level of expectations, called the Fair Stakeholder. They expect to capture values in proportion to the values they create for the project; 2) The stakeholders whose level of salience exceeds the level of their expectations, called the Modest Stakeholder. They create values for the project exceeding their expectations of the project; 3) Another type of stakeholders whose level of expectations exceed their level of salience, called Demanding Stakeholders. Although they do not have considerable

values (added value) for the project, the level of their expectations is more than the level of their salience.

Since there is not a clear boundary between stakeholders' types, the application of fuzzy logic can fill the gap. Thus the stakeholder typology is justified by membership functions in the fuzzy environment to calculate the membership degrees for various stakeholders. As shown in Figure 3, each stakeholder's type can be identified by membership functions within certain intervals.
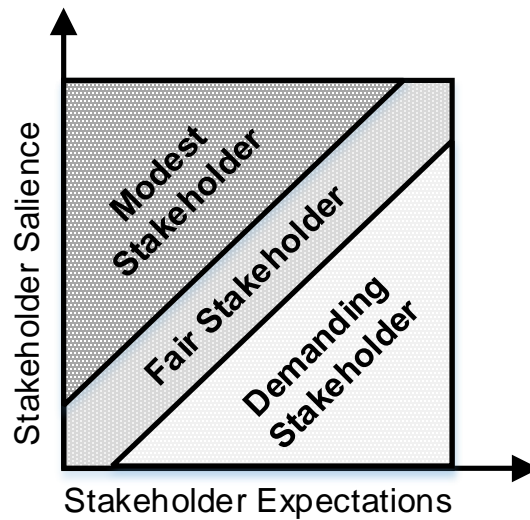


**Figure 3. Stakeholder typology based on the level of salience and expectations**

As seen, identifying stakeholders in these three categories requires comparing the level of stakeholders' salience with the level of their expectations. Therefore, the comparison of project's and stakeholders' value creation for each other is the same comparison of stakeholder salience with expectations.

In order to identify an appropriate tool for balance measurement, it is necessary to describe the requirements of this process. The first requirement is that mutual value creation should be measured by a relative comparison. To compare objects by two indicators, two different approaches can occur: absolute comparison or relative comparison. In this article, we use relative comparison approach to compare the level of salience with expectations. Because stakeholder engagement should be evaluated in the community while stakeholders are commutating with each other, not individually for each stakeholder. The second requirement is that, in measuring the balance, each stakeholder should be assumed and considered as an evaluation system. In order for the project to compare its stakeholders regarding their levels of expectations, it is imperative to imagine that stakeholders' expectations would be fulfilled completely. Therefore, whenever the project encounters the stakeholders' expectations, it assumes that it would satisfy all stakeholders' expectations completely. In this situation: 'Satisfied Expectations = Stakeholder Expectations'. Therefore, the BEM is in accordance with Figure 4. This model shows that in the process of comparing the stakeholders, each stakeholder is like a system wherein expectations play the role of input and the salience plays the role of output.
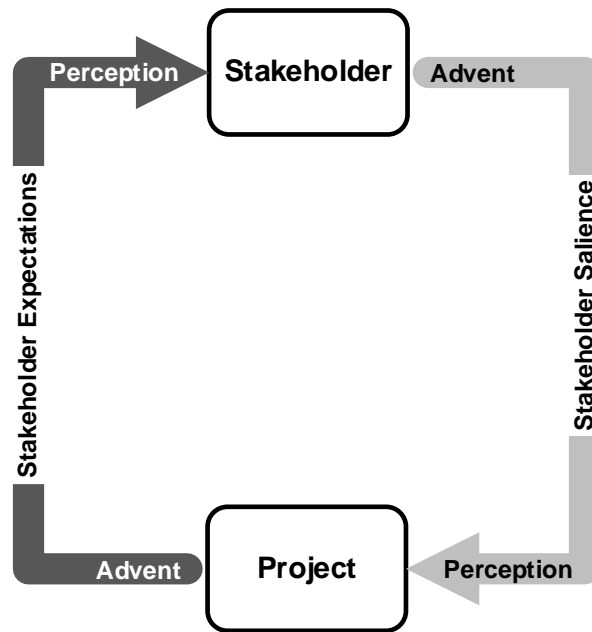
**Figure 4. Balanced Engagement Model (BEM)**

The project and the stakeholders are continuously in various relationships in a network. Figure 5 shows the detailed structure of relationships in BEM. Accordingly, some relationships are based on formal commitments such as the relationship between the project and the stakeholder based on a contract, while others are outside the formal commitments with informal nature. For example, the main contractor may be committed to carry out some activities for six months based on a contract (formal commitment). But he expects the project to extend this range, because of some claims such as weather conditions (informal expectations). The formal commitments that flow from the project to its stakeholder are inherently in balance with the formal commitments that flow from the stakeholder to the project, since both the project and the stakeholders will fulfill the agreements. However, stakeholder engagement in informal relationships has always been the challenge, as it affects the project success as well as stakeholder satisfaction in the real-world. Therefore, this study goes beyond the formal commitments and focuses on informal relationships to recognise and judge the real nature of the project's and the stakeholders' viewpoints in the relationships. For this purpose, this study assumes that all formal commitments are fulfilled by both the project and stakeholders and aims to increase the stakeholders' satisfaction as well as value creation for the project through balancing mutual values.
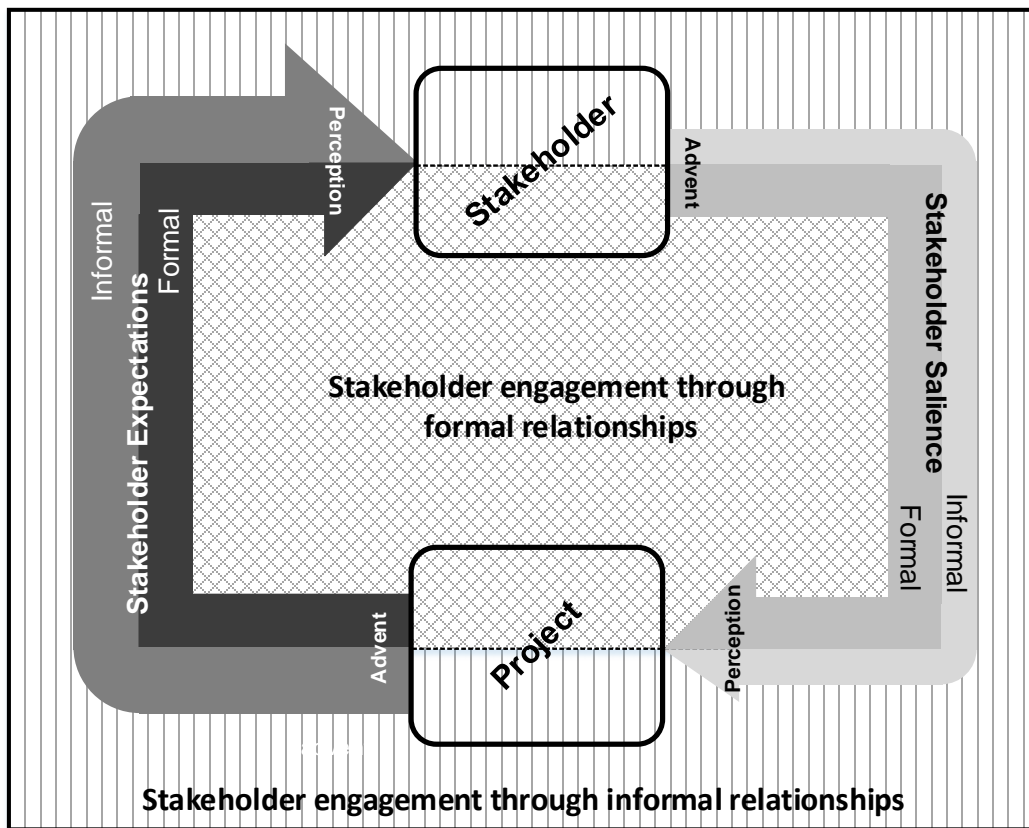
**Figure 5. Structure of relationships in BEM**

## Exploring DEA as a valid tool to measure the balance between stakeholders' salience and expectations

In the following sub-sections, first, we explain the essence of DEA. Second, we explain why DEA is a validated technique for relative comparison. Finally, we propose it for measuring the balance between stakeholders' salience and expectations.

### Essence of DEA

DEA is a nonparametric method for measuring the relative efficiency of a set of homogeneous operational units or DMUs (Afsharian et al. 2017). According to the definition, the system's efficiency is the ratio of outputs divided by inputs. The higher the output or the lower the input, the more efficient the system. DEA utilises mathematical linear programming to determine which of the DMU under study form an envelopment surface named efficient frontier (El-Mashaleh et al. 2007). DEA can be done under two different conditions, which are called input- and output-oriented (Tone and Tsutsui 2017). In the input-oriented model, it is assumed that the evaluation subjects have the ability to change their inputs but cannot change their outputs. In the output-oriented model, assumptions are exactly reversed. The CCR model is the first DEA model with a name consisting of its creators' initials (Charnes, Cooper, and Rhodes) Charnes et al. (1978). This model, which is the basis for many DEA models, is as in Equation (1).

$$Max : \frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \qquad\qquad (1)$$

$$s.t.$$

$$\frac{\sum_{r=1}^{s} u_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}} \leq 1$$

$$u_r \geq 0 \, , v_i \geq 0$$

$$j = 1, 2, 3, \dots, n$$

$s = number\ of\ outputs$

$m = number\ of\ inputs$

$n = number\ of\ units$

In this model, the purpose is to determine the highest efficiency ratio of a particular evaluation subject (DMU) compared with other DMUs. For this reason, the inputs and outputs of other units are included in this model. $v_i$ represents the weight of $i$th input; $u_r$ represents the weight of $r$th output; and $o$ represents the unit index of the underevaluation ($o \epsilon \{1, 2, \ 3, \dots, n\}$ ). $x_{io}$ and $y_{ro}$ are respectively the amount of $i$th input and $r$th output of underevaluation unit (unit$o$). Also, $x_{ij}$ and $y_{rj}$ are the amounts of $i$th input and $r$th output for $j$th unit, respectively. According to this model, the definition of efficiency in DEA is defined as a ratio of the weighted sum of outputs to a weighted sum of inputs. The variables in the model are the same weight of inputs and outputs. That means the model tries to maximise the efficiency of a system in comparison with other systems by determining its weight of inputs and outputs. In such conditions, if a system fails to reach the efficiency frontier (when the amount of efficiency equals 1), it means that there are definitely systems with higher efficiency among those being evaluated. Generally, DEA is an appropriate tool to accommodate large number of inputs and outputs and DMUs. Also, inputs and outputs are not required to have similar units. They can thus be measured by such criteria as monetary sums, time schedule, or subjective scale. DEA frees the decision maker from arbitrary subjective weighting for the different inputs and outputs. The weights can be derived directly from the data. However, DEA allows the decision makers to constrain the weights relevant to different inputs and outputs (El-Mashaleh 2012).

## DEA as a validated technique for relative comparison

In the DEA literature, efficiency is a general term that merely aims to introduce the ratio of system outputs to its inputs (Xiong et al. 2018). Therefore, whenever we could infer the concept of input and output for a system, the concept of efficiency could then be introduced. Considering the specialised literature in the field of evaluation systems, we can create and replace a specialised word with this generic term. The DEA approach has been used as a validated technique in a variety of areas and disciplines for specific purposes such as a ranking, benchmarking, performance, measurement, and decision making (Lin et al. 2005, Bougnol and Dulá 2006, Wang 2011, El-Mashaleh and Minchin Jr 2013, El-Mashaleh and Horta 2015, Yoon and Park 2017). There are two important prerequisite when using DEA: First, evaluation subjects should be homogeneity. Second, the total number of input and output indicators being less than one-third of the number of evaluation subjects. Given certain prerequisites, researchers and practicing professionals can use the DEA tool to compare different objects relatively. The validity of DEA has previously been proved for relative comparison in order to specify efficient DMUs (Martić and Savić 2001, Sueyoshi et al. 2017, Kamitaka et al. 2019). For instance, Figure 6 shows a system with one input, one output, and seven DMUs.
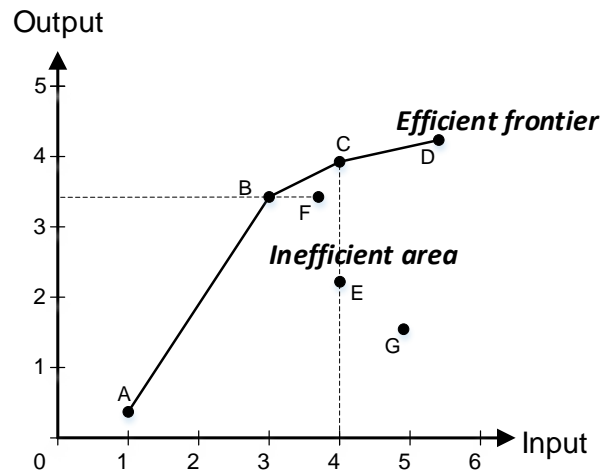
**Figure 6. The concept of efficient frontier**

As it is obvious in Figure 6, the area below the efficient frontier includes inefficient DMUs. For example even though two DMUs "C" and "E" have the same inputs; but "C" is efficient. Because the ratio of output to input in "C" has more amount than "E". This interpretation can be inferred for any points in the area such as "B" and "F". This figure illustrates a system with one input and one output. The more the number of inputs and outputs, the more the complexity in determining efficient frontier and inefficient DMUs. For solving the problems with more inputs and outputs, some softwares such as DEAFrontier have developed to determine efficient frontier.

**Measuring balance between stakeholders' salience and expectations through DEA**

DEA compares a set of evaluation subjects that can be recognised in the form of systems with specific input(s) and output(s), as needed in the second requirement. Therefore, considering the nature of the DEA, it is possible to evaluate a set of evolution subjects as Decision-Making Units (DMUs) based on the various objects that have the essence of input and output. Figure 7 illustrates a set of all project stakeholders in the form of evaluation systems. We consider stakeholder salience and expectations as the respective input and output of the evaluation systems.



**Figure 7. The framework for balancing the value creation between the project and stakeholders**

In this study, the evaluation system in Figure 7 shows that the input of the system is the stakeholder expectations and its output is stakeholder salience. The ultimate goal is to measure the level of balance between these two streams. Therefore, we called the ratio of stakeholder salience (output) to stakeholder expectations (input) the Level of Balance between Expectations and Salience (LBES). Equation 2 shows this index.

$$LBES = \frac{Stakeholders'\ Salience(output)}{Stakeholders'Expectations\ (input)} \quad (2)$$

Whenever the LBES index for a stakeholder is lower than for others, it means the relevant stakeholder has a higher level of expectations compared to salience. In other words, in this condition, the stakeholder is more expectant. From the perspective of value-based engagement, the value that the stakeholder creates for the project is less than its captured value. Thus, whe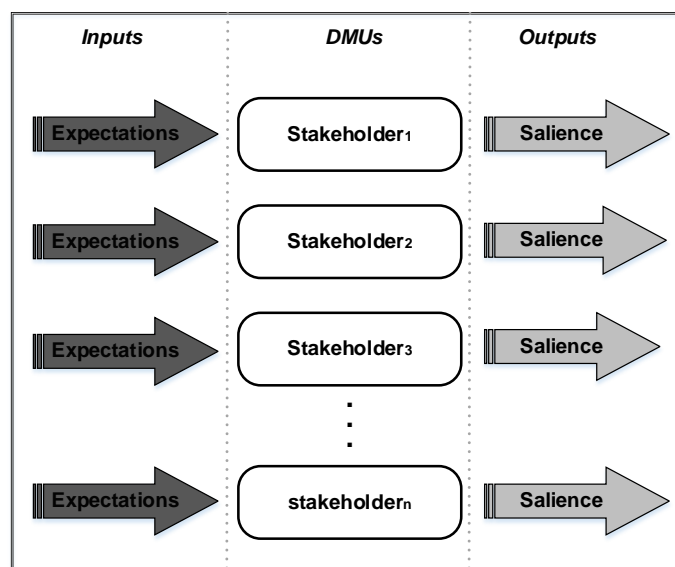n balancing the mutual value creation between the project and its stakeholders, managers must reduce expectations by negotiating or other techniques (Schibi 2013, Yang et al. 2014, PMI 2017). In contrast, whenever the LBES index for a stakeholder is higher compared to others, it means that the level of stakeholder expectations is less than the stakeholder's relative salience. Therefore, despite high salience, the stakeholder has fewer expectations and is Modest. From the perspective of value-based engagement, the value that the stakeholder creates for the project is more than its captured value. Therefore, the managers could balance mutual values and increase project management agility by fulfilling their expectations.

When we use a normal DEA model to measure the LBES index, it would provide amounts between 0 and 1. Accordingly, the stakeholders can be divided into two categories: first, the stakeholders whose LBES indexes are less than 1. The level of these stakeholders' expectations is estimated to be higher than the level of their salience (Demanding Stakeholders). Second are the stakeholders whose LBES indexes are equal to 1, i.e. their level of expectations is not higher than their level of salience (Fair and Modest Stakeholders).

It is impossible to distinguish stakeholders further if we apply only a conventional DEA estimation model. Therefore, we need to use a special form of DEA models called the Super Efficiency-Model (SEM). The SEM identifies the possible capability of a DMU in increasing its inputs and/or reducing its outputs without becoming inefficient by eliminating the constraint associated with a particular efficient DMU (LBES=1) (Aldamak and Zolfaghari 2017, Paradi et al. 2018). By applying this model, we can determine a boundary amount based on the distribution of LBES index, and thereby distinguishing Fair stakeholders from Modest ones. On one side, since the stakeholder expectation's nature is present- and future-oriented, they have the flexibility to be changed by professionals, such as managers; on the other side, since stakeholder salience is past- and present-oriented, they have very low ability and flexibility to be changed. Accordingly, we suggest the input-oriented model to balance between stakeholder salience and expectations.

## Implementation of the model in a case study
In this section, in order to apply the purpose of the study – to balance the stakeholders' salience with stakeholders' expectations – the previous section's innovative theoretical perspective has been applied to an MCP.

## Case study
In order to gain as much insight as possible, we chose what Jacobsen (2005) refers to as an intensive research design. The aim was to gain in-depth and nuanced data from a low number of units, where individual understanding and interpretation were to be highlighted and analysed. We found that a single case-study design would be fitting for our research, with the unit of analysis being the specific MCP. Case studies are especially appropriate for exploratory research when the goal is an in-depth understanding of a phenomenon in its context (Eisenhardt 1989, Yin 2009).

In this article, we studied the implementation phase of the national mega-construction project of Mashhad Urban Railway (Line 2). This project includes a deep tunnel with a 14.5-km route and 13 stations. The majority of this route has been constructed underground. In order to drill the tunnels, the project used Tunnel-Boring Machine (TBM) Drills. The project had a budget of 2,320 billion Iranian riyals and is in Iran classified as a mega construction project. This project was purposely selected for its expected capacity to provide information and to test the theoretical framework.

## Analysis process

The purpose of this article is to present a framework for typologising stakeholders and priority-setting in stakeholder engagement based on mutual value creation between the megaproject and stakeholders. For this purpose, we followed an appropriate engagement plan to classify stakeholders and prioritise responses to their expectations based on LBES index. To classify the stakeholders of Mashhad Urban Railway construction project, we first tried to identify all stakeholders' subsequently, their salience and expectations were determined to obtain the required data for calculating LBES. Then DEA has been used to measure LBES as a balancing index for each stakeholder. In the last step, we classified the stakeholders based on their LBES index. Figure 8 shows the analysis process.
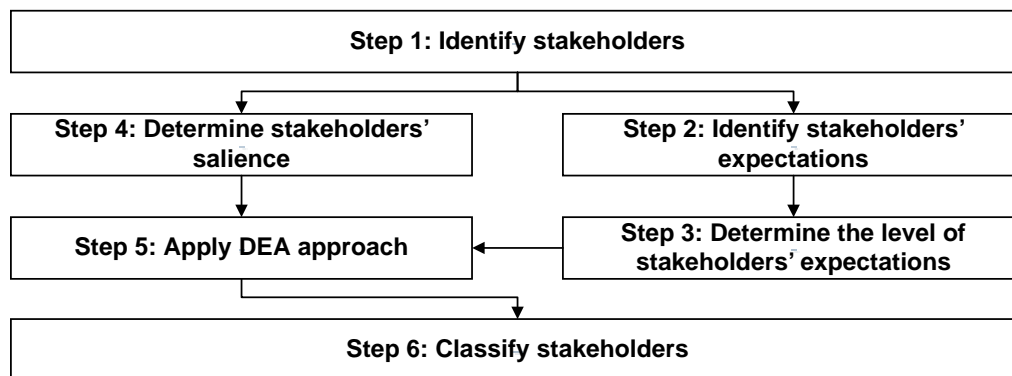


**Figure 8. The process of applying DEA in mega construction project of Mashhad Urban Railway**

## Step 1: Identify stakeholders

The first step for developing a stakeholder engagement plan is to completely and accurately identify stakeholders. In order to collect this information, we interviewed experts of the client corporation. Two prerequisites for selecting experts were an adequate understanding of stakeholders and their expectations and their position being fixed in the main project management team. Finally, 20 qualified experts were selected from the client corporation for participation collecting data. Table 1 shows the interview list.

**Table 1. Overview of interview**

| Interviewees (Numbers) | Date | Duration (for a person) / Form | Topics |
|---|---|---|---|
| Project manager (1) | August 27, 2017 | 45min / Interview | Experiences, roles, and responsibilities |
| Chief Executive Officer (1) | September 12, 2017 | 1 hour / Interview | Experiences, roles, and responsibilities |
| Corporation Consultant (2) | September 12, 2017 | 45min- 1hour / Interview | Experiences, roles, and responsibilities |
| Executive Directors (11) | September 2, 2017 to September 10, 2017 | 45min- 1hour / Workshop | Experiences, roles, and responsibilities |
| Technical Office Experts (5) | September 18, 2017to September 20, 2017 | 45min-1hour / Interview | Experiences, roles, and responsibilities |
| Planning, Budget and IT Director (1) | September 26, 2017 | 1hour / Interview | Experiences, roles, and responsibilities |
| Legal and Contract Affairs Director (1) | September 26, 2017 | 1hour / Interview | Experiences, roles, and responsibilities |

In this study, identifying project stakeholders was carried out in four stages. At first, the experts' response was collected by open questionnaire. The content of this questionnaire included the definition of concept 'stakeholder'. After evaluating responses, we organised them and eventually obtained a preliminary list of project stakeholders. For more accurate stakeholder identification, in the next step, a semi-structured interview was conducted with participants in order to complete the initial list.

The first technique for interviewing was scenario writing, in which four prominent values of the project, which included cost, time, quality, and scope, were produced in the form of a screenplay. Then we asked participants, 'who would benefit from these values and how?' For example, a part of the scenario writing related to expert number 12 was as follows: Scenario 1: What will happen if the project quality is not in accordance with the project's legal agreement with the stakeholders? Who will lose or benefit? Response of expert 12: '... If the quality of the project is not appropriate and in accordance with the legal agreement of the project with the stakeholders, the governor, the municipality, city council, Mashhad Urban Railway Corporation will be dissatisfied ...'.

The second technique during the interviews was storytelling, in which the participants were asked to mention their memoirs from the beginning of the project. The story texts were analysed after the meetings to extract new stakeholders from the story. An example of the storytelling is as follows: A memory from expert 12: '... During the implementation of the project, it was necessary to seise the land that Cultural Heritage, Handicrafts and Tourism Organisation (CHHTO) had in its proprietorship. But this claim and dispute were referred to Provincial Government due to their resistance'. Then the findings were gathered and thereby we asked the project manager to finalise the list of stakeholders. In total, 51 stakeholders were identified. Table 2 shows a complete list of stakeholders in the MUR construction project in its implementation phase.

**Table2. List of stakeholders**

| Code | Stakeholder Names |
|---|---|
| $S_1$ | Mashhad Urban Railway Corporation |
| $S_2$ | Main Client Consultant |
| $S_3$ | Mashhad Municipality |
| $S_4$ | Main Contractor |
| $S_5$ | Engineering Designer |
| $S_6$ | Contractor of Station Construction |
| $S_7$ | Contractor of Route Construction |
| $S_8$ | Contractor of Urban Facilities |
| $S_9$ | Project Equipment Provider |
| $S_{10}$ | Provider of Public Goods for Project |
| $S_{11}$ | Service Provider Company for Project Quality Tests |
| $S_{12}$ | Transport Company |
| $S_{13}$ | Employers Insurance Company |
| $S_{14}$ | Accident Insurance Company |
| $S_{15}$ | Ministry of Economy and Finance |
| $S_{16}$ | Council of Economics |
| $S_{17}$ | Transportation and Traffic Organisation |
| $S_{18}$ | Management and Planning Organisation |
| $S_{19}$ | Client Financial Services (Bank) |
| $S_{20}$ | The Supplier of Goods and Equipment |
| $S_{21}$ | Ministry of Interior |
| $S_{22}$ | National Gas Company |
| $S_{23}$ | Electricity Distribution Company |
| $S_{24}$ | Telecommunication Company |
| $S_{25}$ | Environmental Protection Agency |
| $S_{26}$ | Regional Water Company |
| $S_{27}$ | Provincial Government |
| $S_{28}$ | City Council |
| $S_{29}$ | Provincial Traffic Coordination Council |
| $S_{30}$ | Housing and Urban Development Organisation |
| $S_{31}$ | Social Security Organisation |
| $S_{32}$ | Institute for Standardisation and Industrial Research |
| $S_{33}$ | Water and Wastewater Company |
| $S_{34}$ | Firefighting and Safety Services Organisation |
| $S_{35}$ | Taxi Service Organisation |
| $S_{36}$ | Bus Service Organisation |
| $S_{37}$ | Cultural Heritage, Handicrafts and Tourism Organisation |
| $S_{38}$ | Police Force |
| $S_{39}$ | Rahvar Police |
| $S_{40}$ | Ministry of Commerce |
| $S_{41}$ | Customs Office |
| $S_{42}$ | Railways Administration |
| $S_{43}$ | Islamic Republic of Iran Broadcasting |
| $S_{44}$ | Khorasan Newspaper |
| $S_{45}$ | Shahrara Newspaper |
| $S_{46}$ | Ghods Newspaper |
| $S_{47}$ | Local Landowners |
| $S_{48}$ | The General Public (Adjacent And Passersby) |
| $S_{49}$ | Astan-Qods Razavi |
| $S_{50}$ | Union of Urban & Suburban Railways Companies of Iran |
| $S_{51}$ | Construction Engineering Organisation |

**Step 2: Identify stakeholders' expectations**

In this step, we first reviewed the literature of urban railway line construction projects in Iran to set out an initial list of stakeholders' expectations. For this purpose, we reviewed various papers written in Persian. Also, we reviewed the available information on the websites of the projects. This step aimed to explore all the dimensions of expectations in which the stakeholders had stakes or interest. Then we collected information/data in various situations as follows:

- *The stakeholder was an individual with the possibility of face-to-face meetings*: For this group of stakeholders, information was gathered through a semi-structured interview. The reason behind it was to establish closer contact with stakeholders and achieve clearer and more complete ideas. 63% of stakeholders were in this category.
- *The stakeholders were a group with the possibility of face-to-face meetings:* In this case, with prior coordination, the study was described for the groups. Then, using the Delphi method, the participants expressed their ideas in order to achieve consensus in several rounds. 18% of stakeholders were in this category.
- *The stakeholder was an individual without the possibility of face-to-face meetings*: By calling at a predetermined time, the information/data was recorded as mentioned in the first category. 14% of stakeholders were in this category.
- *The stakeholders were as a group without the possibility of face-to-face meetings:* An appropriate questionnaire with a template was presented to the committee to implement the Delphi method. 5% of the stakeholders were in this category. The final findings of this step are listed in Table 3.

**Table 3. Dimensions of stakeholders' expectations**

| Code | Dimensions of expectations | Description | Corresponding stakeholders (the number of stakeholder codes has only been displayed) |
|------|---------------------------|-------------|------------------------------------------------------------------------------------|
| $E_1$ | Environmental | This dimension focuses on sustainability development. Some stakeholders believe that attention to environmental issues is critical at the implementation phase. | 1,2,3,4,5,6,7,8,9,11,14,16,17, 18,20,22,24,25,30,31,32,34,3 5,36,37,39,41,42,43,44,45,46 ,47,48,50 |
| $E_2$ | Quality | The degree to which a set of inherent characteristics fulfil requirements such as quality of materials. | 1,2,3,4,5,6,7,9,11,13,14,15,1 6,18,20,21,22,24,25,28,29,31 ,32,33,34,35,36,37,38,39,40, 41,42,43,44,45,46,47,48,50 |
| $E_3$ | Legal | This dimension includes legal issues inside and outside the project, e.g. domestic project contracts, national standards and laws. | 1,2,3,4,5,6,8,9,10,14,15,16,1 8,19,20,21,25,26,27,28,29,30 ,31,32,34,35,36,37,38,39,40, 41,43,44,45,46,47,48,49,50 |
| $E_4$ | Physical Scope | This dimension emphasises temporary and permanent sites that must be made available to implement the project plans. | 1,2,3,5,6,7,8,9,11,12,14,16,1 8,21,25,26,27,28,29,30,31,32 ,33,34,35,36,37,39,48,49,50 |
| $E_5$ | Cost | This dimension focuses on the cost of the project related to financial resources required in the implementation phase. | 1,2,3,4,5,6,7,8,9,10,11,12,13, 14,15,16,17,18,19,20,21,22,2 3,24,25,26,27,28,29,30,31,32 ,33,34,35,36,37,38,39,40,41, 42,43,44,45,46,47,48,49,50 |
| $E_6$ | Schedule | This dimension emphasises the time from the start of the project to the completion of the project. | 1,2,3,4,5,6,7,8,9,10,11,12,13, 14,15,16,17,18,19,20,21,22,2 3,24,25,26,27,28,29,30,31,32 ,33,34,3536,37,38,39,40,41,4 2,43,44,45,46,47,48,49,50,51 |
| $E_7$ | Equipment | This dimension relates to the preparation, use, and monitoring of equipment needed for the project. | 1,4,5,8,12,13,14,15,17,18,19, 27,28,31,32,33,38,42,44,45,4 6,47,49,50 |
| $E_8$ | Integrated Management | This dimension refers to the importance of the Project Management Information System (PMIS) in order to integrate project management processes. The most important appearance of this dimension is to focus on project knowledge management and R & D. | 1,2,4,6,8,9,13,19,20,21,23,25 ,33,34,41,42,48,51 |

## Step 3: Determine the level of stakeholders' expectations

Each of the stakeholders may have various expectations depending on the purpose of his/her/its participation in the project. Each dimension of expectations has a specific importance for each stakeholder. For example, a stakeholder may have expectations in the two dimensions 'project schedule' and 'project cost', but the level of one is very high, and the other is very low. In this step, the purpose is to determine the level of stakeholder expectations' importance from their perspective. For this purpose, we used the data collection methods described in the previous step. Table 4 shows the level of expectations for each of the project stakeholders.

**Table 4. The level of stakeholders' expectations**

| Code | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ | $E_7$ | $E_8$ |
|------|------|------|------|------|------|------|------|------|
| $S_1$ | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| $S_2$ | 8.1 | 8.3 | 8.8 | 9 | 9 | 9 | 9 | 8.4 |
| $S_3$ | 7.6 | 7.9 | 9 | 9 | 9 | 9 | 8.8 | 9 |
| $S_4$ | 7.7 | 4.7 | 8.5 | 9 | 9 | 9 | 8.4 | 8.7 |
| $S_5$ | 8.3 | 6.3 | 8.7 | 9 | 8 | 7.9 | 4.9 | 8 |
| $S_6$ | 7.1 | 5.6 | 8.6 | 8.6 | 9 | 8.5 | 8.6 | 7.9 |
| $S_7$ | 7.3 | 6 | 4.8 | 6.7 | 9 | 8.1 | 8.1 | 5.3 |
| $S_8$ | 7.1 | 4.3 | 5.6 | 7 | 9 | 6 | 7.8 | 8.2 |
| $S_9$ | 6.1 | 6.3 | 7.3 | 5.7 | 8.8 | 8.6 | 8.3 | 6.7 |
| $S_{10}$ | 4.8 | 2.8 | 6.6 | 1.9 | 9 | 6.5 | 6.9 | 8.9 |
| $S_{11}$ | 2.3 | 4.2 | 7.3 | 4.6 | 8 | 8.2 | 4.4 | 6.6 |
| $S_{12}$ | 3.9 | 4.4 | 3.9 | 4.2 | 7 | 6.2 | 6.8 | 7.2 |
| $S_{13}$ | 4.8 | 5.7 | 5.2 | 3.8 | 7.8 | 6.3 | 8.2 | 6.3 |
| $S_{14}$ | 7.4 | 6.6 | 8.2 | 4.6 | 6.6 | 4.1 | 5.6 | 2.3 |
| $S_{15}$ | 2.1 | 6.5 | 7.3 | 4.6 | 8.2 | 6.2 | 2.3 | 7.2 |
| $S_{16}$ | 1.8 | 3.9 | 6.8 | 6.2 | 8 | 7.8 | 4.9 | 6.4 |
| $S_{17}$ | 5.2 | 4.7 | 3.2 | 4.3 | 8.6 | 6 | 5 | 7.1 |
| $S_{18}$ | 8.4 | 7.4 | 8.6 | 8.2 | 9 | 9 | 9 | 8.4 |
| $S_{19}$ | 1.4 | 3.4 | 6.2 | 1.8 | 9 | 2.6 | 3.9 | 1 |
| $S_{20}$ | 2.2 | 3.8 | 7.8 | 1.7 | 9 | 3.8 | 8.6 | 2.2 |
| $S_{21}$ | 8.7 | 7.8 | 8.9 | 8.8 | 9 | 8.5 | 7.3 | 8.2 |
| $S_{22}$ | 4.1 | 5 | 6.7 | 3.2 | 4.6 | 4 | 3.3 | 4.7 |
| $S_{23}$ | 3.6 | 3.5 | 4.9 | 4.1 | 7.4 | 6.3 | 3.9 | 6.5 |
| $S_{24}$ | 5.2 | 2.8 | 4.7 | 4.6 | 5.9 | 7.5 | 6.2 | 3.7 |
| $S_{25}$ | 9 | 7.3 | 5.2 | 9 | 6 | 3.6 | 3.2 | 6.2 |
| $S_{26}$ | 6.1 | 5.6 | 6 | 3.8 | 8.4 | 4.1 | 6.9 | 7.2 |
| $S_{27}$ | 8.9 | 8.7 | 8.7 | 9 | 8.1 | 9 | 8.9 | 9 |
| $S_{28}$ | 8.5 | 8.4 | 8.4 | 9 | 7.2 | 8.9 | 7.8 | 8.2 |
| $S_{29}$ | 4.8 | 5.8 | 7.5 | 6.7 | 3.6 | 4.9 | 6.9 | 6.1 |
| $S_{30}$ | 6.1 | 3.7 | 5.6 | 6.8 | 4.7 | 3.8 | 6 | 1.8 |
| $S_{31}$ | 7.6 | 6.1 | 6.7 | 2 | 3.6 | 3.4 | 5 | 2.1 |
| $S_{32}$ | 4.9 | 9 | 4.2 | 2.1 | 4.2 | 3.9 | 5.2 | 8.3 |
| $S_{33}$ | 1.6 | 4 | 4.6 | 6.3 | 4 | 5.6 | 9 | 4.2 |
| $S_{34}$ | 4.6 | 6.5 | 4 | 2.4 | 3.9 | 2.3 | 2.3 | 1 |
| $S_{35}$ | 2.4 | 5.2 | 6.8 | 5.4 | 5.2 | 3.7 | 3.8 | 3.4 |
| $S_{36}$ | 1.7 | 4.1 | 5.9 | 4.1 | 4.2 | 3.3 | 4.1 | 3.6 |
| $S_{37}$ | 3.1 | 2.3 | 4.2 | 4.2 | 4.2 | 3.4 | 2.1 | 3.6 |
| $S_{38}$ | 1.3 | 3.9 | 5.6 | 4 | 5.2 | 3.9 | 2.6 | 2.1 |
| $S_{39}$ | 1.6 | 6.4 | 4.8 | 6.2 | 3.1 | 2.6 | 1.9 | 1.5 |
| $S_{40}$ | 3.1 | 4.8 | 5.9 | 2 | 4 | 3.2 | 2.6 | 6.9 |
| $S_{41}$ | 2 | 3.7 | 5.3 | 1 | 4.3 | 5.6 | 6.4 | 3 |
| $S_{42}$ | 1.7 | 4.2 | 4.9 | 1 | 3.3 | 3.6 | 5.9 | 5.6 |
| $S_{43}$ | 4.4 | 6.2 | 6.8 | 1.5 | 6.7 | 2 | 2.8 | 1 |
| $S_{44}$ | 2.3 | 3.7 | 6.2 | 2.7 | 5.8 | 3.1 | 5 | 2 |
| $S_{45}$ | 6.8 | 6.2 | 7.2 | 3.1 | 4.1 | 4.2 | 7.3 | 1.6 |
| $S_{46}$ | 5 | 5.1 | 4.9 | 3.6 | 3 | 4.3 | 7 | 1 |
| $S_{47}$ | 3.6 | 5.3 | 6.6 | 2 | 1.9 | 5.3 | 6.4 | 4.3 |
| $S_{48}$ | 5.3 | 8.6 | 5.3 | 5.2 | 3.6 | 4.2 | 6.9 | 2.3 |
| $S_{49}$ | 2.9 | 7.3 | 6.7 | 8.6 | 3 | 3.9 | 8.2 | 3.8 |
| $S_{50}$ | 8.8 | 8.4 | 8.7 | 6.5 | 6.2 | 6.3 | 8.6 | 8.6 |
| $S_{51}$ | 1.7 | 2.2 | 3 | 1.7 | 1 | 2.2 | 2.4 | 1.2 |

**Note:**

1. This dimension does not matter to me (us) and is not any part of my (our) goal for participating in the project (Schibi 2013).

3. This dimension has little importance to me (us) and is a little part of my (our) goals for participating in the project.

5. This dimension has ordinary importance to me (us) and is a part of my (our) ordinary goals for participating in the project.

7. This dimension is important to me (us) and is one of my (our) most important goals for participating in the project).

9. This dimension is vital to me (us) and is one of my (our) vital goals for participating in the project.

2, 4, 6 and 8 are intermediate numbers

## Step 4: Determine stakeholders' salience

In determining stakeholders' salience, it is sufficient to determine the level of stakeholders' salience attributes by managers or anyone in project management team who has enough information about stakeholders' salience attributes. First, we distributed a questionnaire among participants based on the Likert scale from 1 to 9 (Table 5). The content of the questionnaire included the definitions of all attributes in accordance with the literature in section "Literature Review". Then the level of three

attributes, 'power, legitimacy and urgency,' was determined quantitatively from every participants' viewpoints. Finally, we averaged their scores. If an expert did not have any opinion about the scores of some attributes of a particular stakeholder, we disregarded that stakeholder when averaging the scores. Table 5 shows the findings of this step.

**Table 5. Stakeholders' salience**

| $S_i$ | Power | Legitimacy | Urgency |
|---|---|---|---|
| $S_1$ | 9 | 9 | 9 |
| $S_2$ | 7.3 | 9 | 9 |
| $S_3$ | 9 | 9 | 9 |
| $S_4$ | 6.5 | 8.4 | 7.2 |
| $S_5$ | 2.2 | 4.6 | 7.2 |
| $S_6$ | 3.9 | 2.2 | 6.5 |
| $S_7$ | 4.4 | 3.1 | 7.1 |
| $S_8$ | 3.5 | 1.8 | 5.7 |
| $S_9$ | 2.2 | 5.4 | 8.3 |
| $S_{10}$ | 5.2 | 3.2 | 5.8 |
| $S_{11}$ | 3.3 | 2.4 | 5.6 |
| $S_{12}$ | 1.8 | 2.1 | 4.1 |
| $S_{13}$ | 2.3 | 1.9 | 5.4 |
| $S_{14}$ | 1.7 | 4.5 | 6 |
| $S_{15}$ | 6.5 | 7.8 | 7.2 |
| $S_{16}$ | 4.8 | 6.6 | 6.6 |
| $S_{17}$ | 6.6 | 5.5 | 2.3 |
| $S_{18}$ | 9 | 9 | 8.9 |
| $S_{19}$ | 5.4 | 3.9 | 3.5 |
| $S_{20}$ | 3.8 | 1.7 | 2.2 |
| $S_{21}$ | 8.8 | 8.3 | 8.5 |
| $S_{22}$ | 4.8 | 8.1 | 7.7 |
| $S_{23}$ | 3.7 | 6.2 | 6.9 |
| $S_{24}$ | 3.5 | 5.3 | 4.1 |
| $S_{25}$ | 4.5 | 8.1 | 4.4 |
| $S_{26}$ | 5.3 | 6.5 | 5.6 |
| $S_{27}$ | 8.8 | 8.6 | 8.3 |
| $S_{28}$ | 8.3 | 8.5 | 8.2 |
| $S_{29}$ | 3.8 | 2.6 | 3.6 |
| $S_{30}$ | 4.5 | 6.2 | 4 |
| $S_{31}$ | 3.7 | 6.6 | 3.1 |
| $S_{32}$ | 5.3 | 7.2 | 4.3 |
| $S_{33}$ | 2.5 | 5.8 | 5.7 |
| $S_{34}$ | 1.4 | 3.5 | 1.9 |
| $S_{35}$ | 1.8 | 3.3 | 2.7 |
| $S_{36}$ | 1.3 | 2.9 | 2 |
| $S_{37}$ | 3.8 | 6.6 | 6.1 |
| $S_{38}$ | 1.5 | 7.8 | 5.4 |
| $S_{39}$ | 1.8 | 6.7 | 5.9 |
| $S_{40}$ | 5.5 | 8.3 | 6 |
| $S_{41}$ | 3.5 | 5.6 | 7.2 |
| $S_{42}$ | 4.1 | 5 | 6.8 |
| $S_{43}$ | 6.8 | 6.9 | 4.4 |
| $S_{44}$ | 2.3 | 5.6 | 3.2 |
| $S_{45}$ | 3.3 | 6.8 | 3.8 |
| $S_{46}$ | 1.9 | 6.6 | 3.6 |
| $S_{47}$ | 1.7 | 2.1 | 5.2 |
| $S_{48}$ | 3.2 | 3.2 | 1.8 |
| $S_{49}$ | 4.9 | 5.2 | 6.3 |
| $S_{50}$ | 7 | 8.6 | 6.9 |
| $S_{51}$ | 2.6 | 5.6 | 3.1 |

**Note**:
1: the level of stakeholder salience attribute (Power/Legitimacy/Urgency) is very low
3: the level of stakeholder salience attribute (Power/Legitimacy/Urgency) is low
5: the level of stakeholder salience attribute (Power/Legitimacy/Urgency) is average
7: the level of stakeholder salience attribute (Power/Legitimacy/Urgency) is high
9: the level of stakeholder salience attribute (Power/Legitimacy/Urgency) is very high
2, 4, 6 and 8 are intermediate numbers

**Step 5: Apply DEA approach**

Stakeholders' expectations and salience are considered as system input and output, respectively. In this situation, the determined level of stakeholder expectations equals the level of manager response. Therefore, in order to calculate the LBES index, we could use this data. Since changing stakeholder salience is not dependent on managers' authorities, we used data from the input-oriented model. The stakeholder's LBES indexes was obtained in accordance with Table 6 under the CRS DEA Model using DEAFrontier software. This software was first developed by Joe Zhu and is a Microsoft® Excel Add-In for solving DEA models and uses the Excel Solver (Zhu 2014). It aims to minimise the possibility of mis-presentation of DEA models during coding. DEAFrontier software includes some models such as Multiplier Model, Undesirable Measure Model, and VRS Model. In the present approach, we encountered an evaluation issue in engaging with stakeholders; we are going to evaluate the balance between input and output value streams. Therefore, stakeholders' expectations and salience are considered as system input and output, respectively. After running the DEA model in the normal form in the DEAFrontier software, the results were obtained according to Table 6. This table shows how much the LBES index is for each stakeholder. The closer each number is to 1, the more balanced it is.

**Table 6. LBES index of stakeholders**

| Code | LBES Index |
|------|------------|
| $S_1$ | 0.8972 |
| $S_2$ | 0.8062 |
| $S_3$ | 0.8988 |
| $S_4$ | 0.8361 |
| $S_5$ | 0.5840 |
| $S_6$ | 0.5204 |
| $S_7$ | 1.0000 |
| $S_8$ | 0.6970 |
| $S_9$ | 0.7930 |
| $S_{10}$ | 1.0000 |
| $S_{11}$ | 0.7756 |
| $S_{12}$ | 0.7212 |
| $S_{13}$ | 0.7259 |
| $S_{14}$ | 0.8249 |
| $S_{15}$ | 1.0000 |
| $S_{16}$ | 1.0000 |
| $S_{17}$ | 1.0000 |
| $S_{18}$ | 0.9279 |
| $S_{19}$ | 1.0000 |
| $S_{20}$ | 0.6902 |
| $S_{21}$ | 0.8885 |
| $S_{22}$ | 1.0000 |
| $S_{23}$ | 0.9785 |
| $S_{24}$ | 0.7846 |
| $S_{25}$ | 0.9510 |
| $S_{26}$ | 0.8610 |
| $S_{27}$ | 0.9012 |
| $S_{28}$ | 0.9112 |
| $S_{29}$ | 0.5623 |
| $S_{30}$ | 0.9118 |
| $S_{31}$ | 0.8647 |
| $S_{32}$ | 1.0000 |
| $S_{33}$ | 1.0000 |
| $S_{34}$ | 0.6423 |
| $S_{35}$ | 0.4192 |
| $S_{36}$ | 0.4256 |
| $S_{37}$ | 1.0000 |
| $S_{38}$ | 1.0000 |
| $S_{39}$ | 1.0000 |
| $S_{40}$ | 1.0000 |
| $S_{41}$ | 1.0000 |
| $S_{42}$ | 1.0000 |
| $S_{43}$ | 1.0000 |
| $S_{44}$ | 0.7171 |
| $S_{45}$ | 0.7616 |
| $S_{46}$ | 1.0000 |
| $S_{47}$ | 1.0000 |
| $S_{48}$ | 0.6152 |
| $S_{49}$ | 0.9870 |
| $S_{50}$ | 0.7964 |
| $S_{51}$ | 1.0000 |

A large proportion of the data in Table 6 is 1. Therefore, we analysed stakeholders by the SEM. Table 7 shows the findings of the SEM analysis.

**Table 7. The findings of SEM**

| Code | LBES Index |
|---|---|
| $S_1$ | 0.8972 |
| $S_2$ | 0.8062 |
| $S_3$ | 0.8988 |
| $S_4$ | 0.8361 |
| $S_5$ | 0.5840 |
| $S_6$ | 0.5204 |
| $S_7$ | 1.0184 |
| $S_8$ | 0.6970 |
| $S_9$ | 0.7930 |
| $S_{10}$ | 1.3143 |
| $S_{11}$ | 0.7756 |
| $S_{12}$ | 0.7212 |
| $S_{13}$ | 0.7259 |
| $S_{14}$ | 0.8249 |
| $S_{15}$ | 1.5846 |
| $S_{16}$ | 1.1349 |
| $S_{17}$ | 1.7955 |
| $S_{18}$ | 0.9279 |
| $S_{19}$ | 2.1654 |
| $S_{20}$ | 0.6902 |
| $S_{21}$ | 0.8885 |
| $S_{22}$ | 1.1393 |
| $S_{23}$ | 0.9785 |
| $S_{24}$ | 0.7846 |
| $S_{25}$ | 0.9510 |
| $S_{26}$ | 0.8610 |
| $S_{27}$ | 0.9012 |
| $S_{28}$ | 0.9112 |
| $S_{29}$ | 0.5623 |
| $S_{30}$ | 0.9118 |
| $S_{31}$ | 0.8647 |
| $S_{32}$ | 1.1560 |
| $S_{33}$ | 1.0024 |
| $S_{34}$ | 0.6423 |
| $S_{35}$ | 0.4192 |
| $S_{36}$ | 0.4256 |
| $S_{37}$ | 1.5707 |
| $S_{38}$ | 1.5496 |
| $S_{39}$ | 1.5988 |
| $S_{40}$ | 1.3011 |
| $S_{41}$ | 1.5736 |
| $S_{42}$ | 1.3503 |
| $S_{43}$ | 1.8776 |
| $S_{44}$ | 0.7171 |
| $S_{45}$ | 0.7616 |
| $S_{46}$ | 1.2019 |
| $S_{47}$ | 1.0453 |
| $S_{48}$ | 0.6152 |
| $S_{49}$ | 0.9870 |
| $S_{50}$ | 0.7964 |
| $S_{51}$ | 2.6176 |

## Step 6: Classify stakeholders

In this step, we classified stakeholders under three types: Demanding, Fair, and Modest. For this purpose, we obtained the full range of values that LBES can earn in three different ranges corresponding to the three types of stakeholders. We organised workshop with the experts to identify stakeholder typology ranges. During the workshop, it became clear that it was not possible to achieve an agreement because the experts were not able to provide definitive boundaries to distinguish the three types of stakeholders. After receiving their views, we found out that some of them suggested to use fuzzy logic method. In fuzzy method, it is necessary to determine the linguistic variables by membership functions in certain intervals. Fuzzy logic is actually a method based on many-valued logic rather than binary logic in which 0 and 1 often illustrate the truth and falsehood. It deals with truth values between 0 and 1, and these values are considered as intensity or degrees of truth. However, after a discussion, we also asked other experts if they have consensus on it. All of them agreed upon using this method to achieve the more accurate results in the real-world.

Since DEA result does not depend on the measurement unit of inputs and outputs, it includes a set of unit-free numbers. Accordingly, we involved the experts in a focus group and asked them to discuss the following subject: "It is assumed that both the created value by a stakeholder for the project and the created value by the project for that stakeholder have the same unit such as a unit of money. Therefore, the ratio of created value by the stakeholder for the project to created value by project for that stakeholder (called LBES in this article) will be a unit-free number. In this situation, discuss how much is the minimum, best, and maximum amounts of the ratio so that the stakeholder can be considered as a Demanding, Fair, and Modest stakeholder?". As LBES is a unit-free number, this assumption is true. Table 8 shows the structure of the discussion subject and the results. Finally, the experts agreed on the intervals as shown in Figure 9. It is notable that they chose amount 3 by rounding the decimal point (2.6176) to the nearest integer.

**Table 8. Determining the interval of each stakeholder type in fuzzy environment**

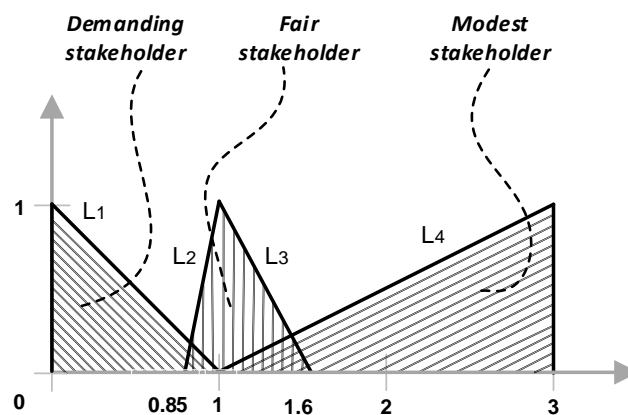| Stakeholder type | Minimum | Best | Maximum |
|---|---|---|---|
| Demanding stakeholder | 0 | 0 | 1 |
| Fair stakeholder | 0.85 | 1 | 1.6 |
| Modest stakeholder | 1 | 3 | 3 |



**Figure 9. Fuzzy functions**

After putting the LBES index of each stakeholder in the equations of linear functions in Figure 9, each stakeholder's classification was identified. Table 9 shows the findings of this step. The cells with bold numbers indicate stakeholder classification. For example, stakeholder $S_{27}$ has been classified as a Fair Stakeholder.

**Table 9. Stakeholder typology**

| $S_i$ | Demanding Stakeholder | Fair Stakeholder | | Modest Stakeholder |
|---|---|---|---|---|
| | $L_1$ | $L_2$ | $L_3$ | $L_4$ |
| $S_1$ | 0.1028 | **0.3144** | | |
| $S_2$ | **0.1938** | | | |
| $S_3$ | 0.1012 | **0.3256** | | |
| $S_4$ | **0.1639** | | | |
| $S_5$ | **0.4160** | | | |
| $S_6$ | **0.4796** | | | |
| $S_7$ | | | **0.9693** | 0.0092 |
| $S_8$ | **0.3030** | | | |
| $S_9$ | **0.2070** | | | |
| $S_{10}$ | | | **0.4761** | 0.1572 |
| $S_{11}$ | **0.2244** | | | |
| $S_{12}$ | **0.2788** | | | |
| $S_{13}$ | **0.2741** | | | |
| $S_{14}$ | **0.1751** | | | |
| $S_{15}$ | | | 0.0257 | **0.2923** |
| $S_{16}$ | | | **0.7752** | 0.0674 |
| $S_{17}$ | | | | **0.3978** |
| $S_{18}$ | 0.0721 | **0.5194** | | |
| $S_{19}$ | | | | **0.5827** |
| $S_{20}$ | **0.3098** | | | |
| $S_{21}$ | 0.1115 | **0.2564** | | |
| $S_{22}$ | | | **0.7678** | 0.0697 |
| $S_{23}$ | 0.0215 | **0.8566** | | |
| $S_{24}$ | **0.2154** | | | |
| $S_{25}$ | 0.0490 | **0.6730** | | |
| $S_{26}$ | **0.1390** | 0.0733 | | |
| $S_{27}$ | 0.0988 | **0.3412** | | |
| $S_{28}$ | 0.0888 | **0.4077** | | |
| $S_{29}$ | **0.4377** | | | |
| $S_{30}$ | 0.0882 | **0.4121** | | |
| $S_{31}$ | **0.1353** | 0.0981 | | |
| $S_{32}$ | | | **0.7401** | 0.0780 |
| $S_{33}$ | | | **0.9961** | 0.0012 |
| $S_{34}$ | **0.3577** | | | |
| $S_{35}$ | **0.5808** | | | |
| $S_{36}$ | **0.5744** | | | |
| $S_{37}$ | | | 0.0489 | **0.2853** |
| $S_{38}$ | | | 0.0841 | **0.2748** |
| $S_{39}$ | | | 0.0020 | **0.2994** |
| $S_{40}$ | | | **0.4982** | 0.1505 |
| $S_{41}$ | | | 0.0439 | **0.2868** |
| $S_{42}$ | | | **0.4161** | 0.1752 |
| $S_{43}$ | | | | **0.4388** |
| $S_{44}$ | **0.2829** | | | |
| $S_{45}$ | **0.2384** | | | |
| $S_{46}$ | | | **0.6636** | 0.1009 |
| $S_{47}$ | | | **0.9246** | 0.0226 |
| $S_{48}$ | **0.3848** | | | |
| $S_{49}$ | 0.0130 | **0.9136** | | |
| $S_{50}$ | **0.2036** | | | |
| $S_{51}$ | | | | **0.8088** |

## Investigating model validation and verification

Overall, this section investigates the theoretical and practical considerations of the proposed model. It is important to investigate the model's feasibility and thereby providing a platform in order to validate and verify the model in the real-world, while addressing the limitations. Thus, we first validated the

model and thereby investigated its verification in the studied case. For this purpose, it was enough to investigate the comprehensiveness of model inputs and outputs. A brainstorming panel as Chapman (1998) suggested, was put together to discuss the comprehensiveness of the model's inputs and outputs. The panel consisting of 12 experts represented a heterogeneous group characterised by different experience and varying personalities. The characteristics of the brainstorming panel is presented in Table 10.

**Table 10. Number of brainstorming panel members and their characteristics**

| Practical field | Academic Field | | |
| --- | --- | --- | --- |
| | Construction Engineering and Management | Project Management | Industrial Engineering and Management |
| Industrial megaprojects (Petrochemical plant construction project) | 1 (MSc.) | 1 (Ph.D) | 1 (Ph.D)* |
| Mega construction projects (Building) | 1 (MSc.) | 1 (MSc.)* | 2 (MSc.) |
| Mega construction projects (Metro) | 1 (Ph.D)* | 1 (Ph.D) | - |
| Mega construction projects (Highway) | 1 (MSc.) and 1 (Ph.D)* | - | 1 (MSc.) |

**Note**: All experts had at least seven-year experience in their practical field. Also, four experts (*) were familiar with DEA.

The brainstorming aimed to investigate validation of the model inputs and outputs. During the meeting, which lasted for 4½ hours, the panel discussed mutual value creation in mega projects. All panel members were asked to generate ideas and explore all possible value streams in megaprojects based on their experience (through storytelling). Finally, all of them agreed that all mutual values can be categorised as stakeholders' expectations and salience which are included as model inputs and outputs. In order to investigate practical verification of the model in the real-world, we went back to the project management team (Table 1) to discuss the findings with them. After a 3½-hour meeting with discussion about the findings and a 4-hour meeting with discussion about the model's applicability for some scenarios consensus was reached on model verification in the case. For example, they believed that although stakeholder $S_4$ (main contractor) creates more values rather than stakeholder $S_{19}$ (bank) for the project, he expects to capture much more values in proportion to the values that he creates for the project. Therefore, after fulfilling all formal commitments, much resources should be allocated to him in the informal environment, while stakeholder $S_{19}$ will be satisfied by receiving fewer resources and also puts more values for project. In other words, with constant resource allocation, $S_{19}$ puts more values in the project rather than $S_4$. So, $S_{19}$ will be more efficient.

## Discussion

In order to fulfil the previous gaps in stakeholder engagement in the megaprojects, this article presented a model in which the mutual values are considered to typologise and classify stakeholders. The findings of this study helps managers to engage with stakeholders from a novel value-based lens. From this perspective, we assumed that managers would respond to all stakeholder expectations, then the LBES index was determined, and thereby we prioritised the attention to their expectations. According to the findings of this study, after fulfilling formal commitments, in stakeholder engagement, satisfying the Modest's stakeholders' expectations should always be the first priority because the values that they create for the project is more than the values they take from it. After the Modest stakeholders, Fair stakeholders' expectations should be the next priority; their value creation equals the value that they gain from it. Demanding stakeholders are at the last priority, because they capture more value than they create. As proper engagement, negotiating with these stakeholders reduces conflicting expectations among the stakeholder community (Thekdi and Lambert 2013, Mok et al. 2015). In this way, the choice

of communication methods should allow flexibility in the event that the membership of the stakeholder community changes or their expectations change (Gentle 2005, PMI 2017).

While it is known from research that the emphasis has solely been on stakeholder salience (e.g. Eyiah-Botwe et al. (2016); Mitchell et al. (1997); Friedman and Miles (2006)), this study shows that although some stakeholders, such as such as the main contractor and the reginal water company, had high levels of salience, their LBES index was low. Thus, it should not be thought that they should be the first priority and their expectations must be fulfilled. Because this kind of stakeholder, despite high value creation for the project, also has a high level of expectations. Therefore, fulfilling their expectations disturbs the balance of mutual value creation, unless the project has no resource constraints or its expectations are included in the commitments. Under such conditions, the project has not optimised the allocation of its resources. However, because of many formal commitments in the real-world such as contracts between the project and stakeholders, managers are enforced to allocate resources while disregarding the findings of this study. Because the flow of formal commitments between the project and stakeholder is inherently in balance. In such a situation, it is better to set up the new contracts based on the proposed model and allocate the surplus resources to stakeholders as the model suggests, since the model considers all influencing factor creating mutual values (all possible dimensions of stakeholder expectations and salience attributes) for stakeholder engagement. The findings also reveal that although the level of expectations of some stakeholders is low, it should not be thought that it is more necessary to fulfil their expectations rather others due to lower allocation of resources; this kind of stakeholder may have a low LBES index, such as the Firefighting and Safety Services Organisation. However, in some previous studies, the emphasis has solely been on stakeholder expectations (e.g. Hartmann and Hietbrink (2013); Smith and Love (2004); Li et al. (2012); and Kometa et al. (1995)).

As an important practical contribution, Table 11 shows a stakeholder engagement plan to satisfy stakeholders fairly for the case study. Data collection was conducted in two main steps to identify the level (intensity) of stakeholders' salience and expectations in the informal environment. For this purpose, we first justified the project management team and stakeholders that they have been committed by formal relationships and thus they have to fulfill all agreements such as contracts. Then, they were questioned about informal relationships. However, the question for identification of the intensity of expectations from a stakeholder was as follows: "since all commitments should be fulfilled in the formal environment, how much important is this dimension for you in the informal environment (beyond the formal commitments such as contracts) that if managers do not allocate new resources for these important expectations you will stop your participation and collaboration in the project?". Also, the question for identification of the intensity of stakeholders' salience from project management team was as follows: "since all commitments should be fulfilled in the formal environment, how much potential is this stakeholder to create new values in the line of project goals and success by this dimension (e.g. increasing power alliance in line of project goals), beyond the formal commitments?". Since this mega project was a national construction project with very complex relationships, many governmental and non-governmental organisations had been involved with various expectations. Thus, the stakeholders' roles may be different than anticipated since the real data is affected from the perception of informal relationships. For example, stakeholder $S_{51}$ was an organisation that controlled the buildings around the megaproject and was interested in the quality of the buildings after drilling the tunnels. According to Table 4, the levels of all expectations for stakeholder $S_{51}$ were not more than 3. Therefore, they were of low importance. In other words, this stakeholder would continue his activity without any considerable attention to his expectations. Stakeholder $S_{51}$ stated that since the project was careful in the legal issues and the quality of drilling the tunnels was based on available standards, he did not have high level of expectation, especially about expectations $E_2$ and $E_3$.

**Table 11. Stakeholder engagement plan**

| Stakeholder typology | Stakeholder priority | Stakeholder code | LBES index | Membership function value | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ | $E_7$ | $E_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Modest stakeholders | 1 | $S_{51}$ | 2.6176 | 0.8088 | 1.7 | 2.2 | 3 | 1.7 | 1 | 2.2 | 2.4 | 1.2 |
| | 2 | $S_{19}$ | 2.1654 | 0.5827 | 1.4 | 3.4 | **6.2** | 1.8 | **9** | 2.6 | 3.9 | 1 |
| | 3 | $S_{43}$ | 1.8776 | 0.4388 | 4.4 | **6.2** | **6.8** | 1.5 | **6.7** | 2 | 2.8 | 1 |
| | 4 | $S_{17}$ | 1.7955 | 0.3978 | **5.2** | 4.7 | 3.2 | 4.3 | **8.6** | **6** | 5 | **7.1** |
| | 5 | $S_{39}$ | 1.5988 | 0.2994 | 1.6 | **6.4** | 4.8 | **6.2** | 3.1 | 2.6 | 1.9 | 1.5 |
| | 6 | $S_{15}$ | 1.5846 | 0.2923 | 2.1 | **6.5** | **7.3** | 4.6 | **8.2** | **6.2** | 2.3 | **7.2** |
| | 7 | $S_{41}$ | 1.5736 | 0.2868 | 2 | 3.7 | **5.3** | 1 | 4.3 | **5.6** | 6.4 | 3 |
| | 8 | $S_{37}$ | 1.5707 | 0.2853 | 3.1 | 2.3 | 4.2 | 4.2 | 4.2 | 3.4 | 2.1 | 3.6 |
| | 9 | $S_{38}$ | 1.5496 | 0.2748 | 1.3 | 3.9 | **5.6** | 4 | **5.2** | 3.9 | 2.6 | 2.1 |
| Fair stakeholders | 10 | $S_{42}$ | 1.3503 | 0.4161 | 1.7 | 4.2 | 4.9 | 1 | 3.3 | 3.6 | **5.9** | 5.6 |
| | 11 | $S_{10}$ | 1.3143 | 0.4761 | 4.8 | 2.8 | **6.6** | 1.9 | **9** | **6.5** | **6.9** | **8.9** |
| | 12 | $S_{40}$ | 1.3011 | 0.4982 | 3.1 | 4.8 | **5.9** | 2 | 4 | 3.2 | 2.6 | **6.9** |
| | 13 | $S_{46}$ | 1.2019 | 0.6636 | 5 | **5.1** | 4.9 | 3.6 | 3 | 4.3 | **7** | 1 |
| | 14 | $S_{32}$ | 1.1560 | 0.7401 | 4.9 | **9** | 4.2 | 2.1 | 4.2 | 3.9 | **5.2** | **8.3** |
| | 15 | $S_{22}$ | 1.1393 | 0.7678 | 4.1 | 5 | **6.7** | 3.2 | 4.6 | 4 | 3.3 | 4.7 |
| | 16 | $S_{16}$ | 1.1349 | 0.7752 | 1.8 | 3.9 | **6.8** | 6.2 | **8** | **7.8** | 4.9 | **6.4** |
| | 17 | $S_{47}$ | 1.0453 | 0.9246 | 3.6 | **5.3** | **6.6** | 2 | 1.9 | **5.3** | 6.4 | 4.3 |
| | 18 | $S_7$ | 1.0184 | 0.9693 | **7.3** | **6** | 4.8 | **6.7** | **9** | **8.1** | **8.1** | 5.3 |
| | 19 | $S_{33}$ | 1.0024 | 0.9961 | 1.6 | 4 | 4.6 | **6.3** | 4 | **5.6** | **9** | 4.2 |
| | 20 | $S_{49}$ | 0.9870 | 0.9136 | 2.9 | **7.3** | **6.7** | **8.6** | 3 | 3.9 | **8.2** | 3.8 |
| | 21 | $S_{23}$ | 0.9785 | 0.8566 | 3.6 | 3.5 | 4.9 | 4.1 | **7.4** | **6.3** | 3.9 | **6.5** |
| | 22 | $S_{25}$ | 0.9510 | 0.6730 | **9** | **7.3** | **5.2** | **9** | **6** | 3.6 | 3.2 | **6.2** |
| | 23 | $S_{18}$ | 0.9279 | 0.5194 | **8.4** | **7.4** | **8.6** | **8.2** | **9** | **9** | **9** | **8.4** |
| | 24 | $S_{30}$ | 0.9118 | 0.4121 | **6.1** | 3.7 | **5.6** | **6.8** | 4.7 | 3.8 | **6** | 1.8 |
| | 25 | $S_{28}$ | 0.9112 | 0.4077 | **8.5** | **8.4** | **8.4** | **9** | **7.2** | **8.9** | **7.8** | **8.2** |
| | 26 | $S_{27}$ | 0.9012 | 0.3412 | **8.9** | **8.7** | **8.7** | **9** | **8.1** | **9** | **8.9** | **9** |
| | 27 | $S_3$ | 0.8988 | 0.3256 | **7.6** | **7.9** | **9** | **9** | **9** | **9** | **8.8** | **9** |
| | 28 | $S_1$ | 0.8972 | 0.3144 | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** |
| | 29 | $S_{21}$ | 0.8885 | 0.2564 | **8.7** | **7.8** | **8.9** | **8.8** | **9** | **8.5** | **7.3** | **8.2** |
| Demanding stakeholders | 30 | $S_{31}$ | 0.8647 | 0.1353 | **7.6** | **6.1** | **6.7** | 2 | 3.6 | 3.4 | 5 | 2.1 |
| | 31 | $S_{26}$ | 0.8610 | 0.1390 | **6.1** | **5.6** | **6** | 3.8 | **8.4** | 4.1 | **6.9** | **7.2** |
| | 32 | $S_4$ | 0.8361 | 0.1639 | **7.7** | 4.7 | **8.5** | **9** | **9** | **9** | **8.4** | **8.7** |
| | 33 | $S_{14}$ | 0.8249 | 0.1751 | **7.4** | **6.6** | **8.2** | 4.6 | **6.6** | 4.1 | **5.6** | 2.3 |
| | 34 | $S_2$ | 0.8062 | 0.1938 | **8.1** | **8.3** | **8.8** | **9** | **9** | **9** | **9** | **8.4** |
| | 35 | $S_{50}$ | 0.7964 | 0.2036 | **8.8** | **8.4** | **8.7** | **6.5** | **6.2** | **6.3** | **8.6** | **8.6** |
| | 36 | $S_9$ | 0.7930 | 0.2070 | **6.1** | **6.3** | **7.3** | **5.7** | **8.8** | **8.6** | **8.3** | **6.7** |
| | 37 | $S_{24}$ | 0.7846 | 0.2154 | **5.2** | 2.8 | 4.7 | 4.6 | **5.9** | **7.5** | **6.2** | 3.7 |
| | 38 | $S_{11}$ | 0.7756 | 0.2244 | 2.3 | 4.2 | **7.3** | 4.6 | **8** | **8.2** | 4.4 | **6.6** |
| | 39 | $S_{45}$ | 0.7616 | 0.2384 | **6.8** | **6.2** | **7.2** | 3.1 | 4.1 | 4.2 | **7.3** | 1.6 |
| | 40 | $S_{13}$ | 0.7259 | 0.2741 | 4.8 | **5.7** | **5.2** | 3.8 | **7.8** | **6.3** | **8.2** | **6.3** |
| | 41 | $S_{12}$ | 0.7212 | 0.2788 | 3.9 | 4.4 | 3.9 | 4.2 | **7** | **6.2** | **6.8** | **7.2** |
| | 42 | $S_{44}$ | 0.7171 | 0.2829 | 2.3 | 3.7 | **6.2** | 2.7 | **5.8** | 3.1 | 5 | 2 |
| | 43 | $S_8$ | 0.6970 | 0.3030 | **7.1** | 4.3 | **5.6** | **7** | **9** | **6** | **7.8** | **8.2** |
| | 44 | $S_{20}$ | 0.6902 | 0.3098 | 2.2 | 3.8 | **7.8** | 1.7 | **9** | 3.8 | **8.6** | 2.2 |
| | 45 | $S_{34}$ | 0.6423 | 0.3577 | 4.6 | **6.5** | 4 | 2.4 | 3.9 | 2.3 | 2.3 | 1 |
| | 46 | $S_{48}$ | 0.6152 | 0.3848 | **5.3** | **8.6** | **5.3** | **5.2** | 3.6 | 4.2 | **6.9** | 2.3 |
| | 47 | $S_5$ | 0.5840 | 0.4160 | **8.3** | **6.3** | **8.7** | **9** | **8** | **7.9** | 4.9 | **8** |
| | 48 | $S_{29}$ | 0.5623 | 0.4377 | 4.8 | **5.8** | **7.5** | **6.7** | 3.6 | 4.9 | **6.9** | **6.1** |
| | 49 | $S_6$ | 0.5204 | 0.4796 | **7.1** | **5.6** | **8.6** | **8.6** | **9** | **8.5** | **8.6** | **7.9** |
| | 50 | $S_{36}$ | 0.4256 | 0.5744 | 1.7 | 4.1 | **5.9** | 4.1 | 4.2 | 3.3 | 4.1 | 3.6 |
| | 51 | $S_{35}$ | 0.4192 | 0.5808 | 2.4 | **5.2** | **6.8** | 5.4 | **5.2** | 3.7 | 3.8 | 3.4 |

As Table 11 shows, the project management team can specify which stakeholder has the highest priority to be satisfied. For example, since $S_{19}$ is a Modest stakeholder and $S_{22}$ is a Fair stakeholder, stakeholder $S_{19}$ should be prioritised, after fulfilling the formal commitments. The project management team should only allocate the necessary resources to meet his expectations, after fulfilling all the formal

commitments. In this way, stakeholder $S_{22}$ is prioritised before stakeholder $S_{13}$, since stakeholder $S_{22}$ is a Fair stakeholder, while stakeholder $S_{13}$ is a Demanding stakeholder.

In the following, the data and results of some particular stakeholders are being discussed. First, we have chosen to focus on the stakeholders with the highest and the lowest level of expectations. After averaging the level of all dimensions of expectations for each stakeholder (Table 4), results show that the two stakeholders $S_1$ and $S_{51}$ have the highest and lowest level of expectations, respectively. Second, we have chosen to focus on the stakeholders at the top and bottom of Table 11 (stakeholders $S_{51}$ and $S_{35}$). Thus, stakeholders $S_1, S_{35}, S_{51}$ have been selected. After averaging the salience attributes (Table 5) for each stakeholder, the level of salience for stakeholders $S_1, S_{35}$, and $S_{51}$ are $1^{st}$, $48^{th}$, and $40^{th}$ among stakeholder community, respectively. However, as Table 11 shows, $S_1$ is a Fair stakeholder and the $28^{th}$ stakeholder in the stakeholder engagement plan, $S_{35}$ is a Demanding stakeholder and the $51^{st}$ stakeholder in the stakeholder engagement plan, and $S_{51}$ is a Modest stakeholder at the top of the stakeholder engagement plan. According to Table 11, there is not any shared expectation with high importance (more than 5) between the two stakeholders $S_1$ and $S_{35}$ and stakeholder $S_{51}$. However, stakeholders $S_1$ and $S_{35}$ have some shared expectations ($E_2$, $E_3$, $E_4$, and $E_5$). Therefore, the manager should allocate the necessary resources to stakeholder $S_1$ rather than to stakeholder $S_{35}$, after fulfilling all the formal commitments. Because, although stakeholder $S_1$ has the highest level of expectations in all dimensions, it has the highest level of salience too. Thus, managers should be more careful about stakeholder $S_1$'s expectations $E_2$, $E_3$, $E_4$, and $E_5$, after fulfilling all the formal commitments.

The elements relevant to bolded numbers (important expectations for stakeholders) shows that the corresponding expectations should be satisfied based on the stakeholders' priority. For example, the project management team should satisfy expectations $E_3$ and $E_5$ for stakeholder $S_{19}$ and expectations $E_7$ and $E_8$ for stakeholder $S_{42}$. These elements also specify the corresponding stakeholders that should participate in the decision-making workshops. We will argue that it is important to pay more attention to the stakeholders' types in the decision-making workshops. For example, if there is a conflict in expectation $E_1$, stakeholder $S_{17}$'s opinion should be prioritised, except for formal commitments where all stakeholders are prioritised. Therefore, the project management team should assign more weight to the stakeholder's viewpoints in a decision-making process. The column of stakeholder priority shows whose expectations should be satisfied first, especially when there are conflicting expectations. In such a situation, the project management team should pay attention to stakeholder priority and thereby the importance of stakeholders' expectations. In the case of surplus resources, the project management team should satisfy other expectations with lower importance based on the stakeholders' priority. For example, if expectation $E_3$ is shared between stakeholders $S_{10}$ and $S_{19}$, the managers should pay more attention to stakeholder $S_{19}$'s demands in comparison with stakeholder $S_{10}$' demands, after fulfilling all the formal commitments. Due to the dynamic nature of mega construction projects, stakeholders' salience and expectations change over time. Therefore, project manager and project management team must update the information/data related to system inputs and outputs while implementing megaprojects (Chan and Oppong 2017, PMI 2017).

In this study the proposed model has been validated and verified through several steps. First, we explored and explained DEA as a validated tool for relative comparison. Second, we adopted it for balancing mutual values in stakeholder engagement, while drawing on several theories. Third, the academic and practical experts participated to discuss the model's inputs and outputs. Finally, we applied the model in a real-case and investigated its verification by project management team. The findings confirmed the model validation and verification.


## Conclusion and Contribution

The purpose of this article is to present a framework for priority-setting in stakeholder engagement based on the balance of mutual value creation between the megaproject and stakeholders. To test the framework, the mega construction project of Mashhad Urban Railway in Iran was studied. This study offers several contributions. First, the study contributes to the development of a new school of thoughts for stakeholder engagement by drawing on several theories including "stakeholder theory", "value

creation theory", "expectation disconfirmation theory", and "fuzzy theory". In this study, we looked at MCPs from a novel perspective based on balancing and optimising mutual value creation. Second, a key contribution from this study is the development of stakeholder engagement insights in a platform that prioritises the response to stakeholders' expectations whilst considering to their efficiency and mutual value creation between the megaproject and stakeholder community. Third, we rationalise that the most successful outcome for a megaproject would be creating value proportional to the values that stakeholders put into it (balanced stakeholder engagement). In other words, the higher the stakeholders' salience, the more complete and rapid the response to their expectations must be. Second, we develop a framework to balance value streams between megaproject and stakeholders (stakeholders' expectations and salience). Fourth, we typologise stakeholders based on the proportional of their salience to their expectations.

In the study we applied the DEA approach, which is generally used for organisational performance. In the DEA approach, we considered the community of megaproject's stakeholders as an evaluation system. The system inputs are the expected values of stakeholders (expectations). The system outputs are the values created by stakeholders (salience) for megaprojects. From this perspective, the LBES index was introduced to classify and prioritise the stakeholders. Applying the DEA approach will have many benefits, such as reducing project risks, reducing stakeholder claims, targeted and optimised use of project resources, satisfying stakeholders, and so on. By implementing the presented approach in a real megaproject, we tried to mature the theoretical knowledge. The LBES index was determined after analysing the data by DEAFrontier software and transferring it to the fuzzy environment, thereby determining and prioritising stakeholder engagement. The type of stakeholder engagement was also the same identified in the dimensions of expectations.

The results of this study can be used by practicing professionals such as project managers when identifying, categorising, and managing stakeholder engagement in large construction projects such as MCPs. Particularly, this study categorises stakeholders based on the proportional of their salience to expectations to three main types: "Modest", "Fair" and "Demanding". This typology will provide a road map for managers to prioritise the responses to stakeholders' expectations and setting up the new contracts.

## Future Research
This study has some weaknesses that have implications for further research. First, it aims to prioritise the response to stakeholder expectations fairly in order to balance mutual values. Future research should focus on how to allocate the resources after determining the response priority. Although this study contributes to prioritise stakeholders and the response to stakeholder expectations fairly by their LBES, it does not include an approach to determine clearly how to translate expectations from the qualitative status to quantitative data. Therefore, future research should consider the degree of response to each expectation and go beyond this research in which we assumed either managers respond to an expectation completely or do not respond to it at all. Second, it is suggested that a sensitivity analysis should be carried out in future studies. It enables managers to experience more flexible engagement with stakeholders. In this case, it is possible to analyse and optimise stakeholder engagement by changing expectations. Third, due to the limitation of resources, this study only focused on stakeholder classification based on mutual value creation without considering higher levels of strategies. In order to develop this research, we suggest establishing a relationship between different levels of strategies using DEA. Fourth, we only studied mega-construction projects. We theorise that this approach can also be implemented for other, more diverse large projects. Therefore, we suggest researchers investigate DEA in other large projects, using lessons learned herein to develop knowledge and commercialise comprehensive software.

## Data Availability Statement

Some or all data, models, or code generated or used during the study are available from the corresponding author by request. (Level of stakeholders' expectations and stakeholders' salience before averaging.)

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## Conflict of interest

There is no conflict of interest.

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