



# Development and assessment of an instrument to measure equivocal situation and its causes in IS/IT project evaluation

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## **Abstract:**

Project evaluations are vital for organizations to manage and balance the costs and benefits of their IS/IT investment. Despite the importance of project evaluations, equivocal situation may limit the effectiveness of an evaluation and hinder decision-makers in generating purposeful resolutions. There is a dearth of empirical studies with regard to equivocal situation, which this study addresses by developing and measuring a construct of an equivocal situation and its causes. The equivocal situation construct is derived from the notion of equivocality and its causes are extracted from the extant literature. The developed constructs are subjected to empirical validation through Partial Least Squares (PLS) analysis by employing the data collected from knowledge professionals in IS/IT project management. The developed instrument provides a firm foundation for future studies of equivocality in IS/IT project evaluation.

## **Keywords:**

evaluation; equivocality; information system/technology projects; measurement; instrument; development; assessment.

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## 1. Introduction

Many organizations invest enormously in information systems and technology (IS/IT) and become reliant on the success of their IS/IT portfolios and projects. Charette [1] reminds organizations of the importance to improve their IS/IT project execution due to many project failures and their related costs. Proper evaluations are beneficial to discover problems during project development and implementation. Evaluations are processes conducted by groups of decision-makers or evaluators to describe the realization of resources for their merit and worth; they judge and compare a set of standards suitable for the context, followed by decisions [2]. The prior-justified plans and business cases can then be reestablished to maintain adequate returns of the investments, and to further proceed with well-positioned strategies [3]. However, evaluations are not perceived as trouble-free practices. For instance, evaluating the progress rate of the development of an information system is problematical due to its intangibility especially during the initial stage [4]. Hence, organizations seem to have difficulty deploying proper evaluations [5].

From a research perspective, evaluating information systems and technology in organizations still remain a challenge and an interesting subject to explore. Especially as studies related to the evaluation of on-going projects are still limited. This study connects IS/IT evaluation literature to the continuation decisions of IS/IT projects. Arguably, evaluations are performed to justify choices of actions which result in decisions [3, 6, 7]. We introduce the concept of equivocal situations, derived from the notion of equivocality, by subscribing to Bowen's Decision Dilemma theory [8]. An equivocal situation raises potential problems of unwarranted continuation and premature termination in decision-making and hinders organizations in deciding purposefully on the projects' next course of action [9, 10]. Despite the importance of equivocal situations in affecting continuation decisions, the causes of equivocal situations are not well recognized [11]. Moreover, empirical studies of factors that affect an equivocal situation and their influence on project evaluations demand the development of a reliable and valid instrument. From a practical perspective, the instrument will provide practitioners with the knowledge to analyze their project execution in order to lessen the equivocal situations especially at the time of evaluation. By understanding of the characteristics of equivocal situations and their causes, organizations take the first step to structure and manage their IS/IT project portfolios as well as to sustain effective project execution.

The purpose of this study is to develop and assess an instrument to measure equivocal situations in IS/IT project evaluations. The stages comprise qualitative exploration, instrument development, and quantitative assessment. The study proceeds as follows: we describe the extant studies and the relevant theoretical background on the main concepts of our study, i.e., evaluation, continuation decisions, and equivocality. Next, we describe the methodology and procedure for instrument development and assessment; we present in detail the development process, the analysis through Partial Least Squares (PLS) and the result of the developed instrument. Subsequently, we highlight our contribution to research and practice, and the entailed limitations. Finally, we conclude the study with suggestions for further development.

## 2. Theoretical foundation

### 2.1 Evaluation

Irani, et al. [12] define IS/IT evaluation as *"a decision-making technique that allows an organization to benchmark and define costs, benefits, risks and implications of investing in IT/IS systems and infrastructures"* (p. 213). Additionally, Farbey, et al. [13] describe IS/IT project evaluation as *"a process, or group of parallel processes, which take place at different points in time or continuously, for searching and for making explicit, quantitatively or qualitatively, all the impacts of an IT project and the programme and strategy of which it is a part"* (p. 190). Evaluation can be construed as a way to manage and balance the costs and benefits throughout project execution in relation to new emerging insights of the project [14]. Thus, the aim of evaluating on-going projects is: (1) to specify the projects' progress and likely success; (2) to consider the value of continuing the projects, and; (3) to allow the intervention of projects which deviate from their plan [7, 15, 16]. As the evaluation outcome will be the reference point of project continuation decisions and

the subsequent strategies, evaluation should ascertain the project's condition unequivocally [15, 16]. However, evaluation is challenged by the difficulty to determine the project's condition and the equivocality of information surrounding the project [4, 15, 17, 18]. Decisions to continue IS/IT projects become a problematic issue for organizations [19].

## 2.2 Equivocal situation

One of the prominent theories as to why decisions are taken by organizations to continue with troubled IS/IT projects is the Decision dilemma, coined by [8]. We subscribe to Bowen's conjecture of equivocality, referring to information for which multiple (positive or negative) interpretations can be constructed [8]. The theory posits that continuation decisions of troubled IS/IT projects are seen more as dilemmas rather than errors of decision-making. When information surrounding the projects is deemed to be ambiguous, equivocal situations might emerge and lead to escalation [20]. Evaluating and deciding on the continuation of IS/IT projects in an equivocal situation may lead decision-makers to an unwarranted continuation or a premature termination. Decision-makers are unable to grasp a clear picture of the likely success or failure of the projects. Decision-makers may not be able to make a purposeful decision on the next course of action. Unwarranted continuation decisions may be seen as irrational behavior, which traps decision-makers in a difficult situation. Unwarranted continuation causes the project to absorb a great deal of resources without a clear end point. In many cases, the projects often end up being abandoned or are redirected, but usually too late. Likewise, premature abandonment is also considered as problematical as it may cause organizations to miss opportunities or future benefits from the investments and to lose on deployment costs [10]. Continuation decisions, inevitably, become crucial for organizations in the management of their IS/IT portfolio.

Several causes of equivocal situations are implicitly mentioned in some studies. For instance, lack of clarity about projects' success and failure criteria, vagueness of project charter, or ambiguity of information surrounding the projects execution [15, 21, 22]. These are deemed to induce equivocal situations. However, extant studies have not explored the concepts of equivocality in IS/IT projects specifically, thus the phenomenon and the causes are not well understood. Evaluating the IS projects is often challenged by disagreement due to multiple interpretation of information surrounding the project and the difficulty to establish evaluation criteria, utilize the evaluation techniques and tools, and to obtain adequate data to support the decision-making. This situation raises confusion and dilemma, as described by Bowen.

## 3. Instrument development process

We describe the approach taken when developing and testing an instrument to measure the extent of an equivocal situation as well as the causes of such situations [23]. Fig. 1 depicts the stages and the employed methods to develop and assess the instrument.

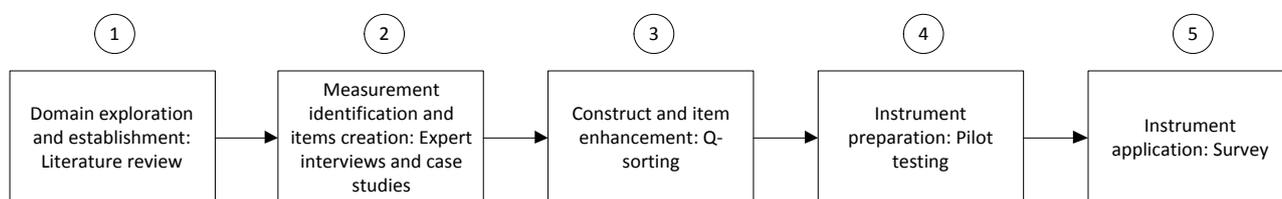


Fig. 1. Stages and methods

### 3.1 Domain exploration

In the first stage, we examined the notion of equivocality to improve our understanding of the notion and to identify its common characteristics. The literature was collected by entering the key terms: (escalat\* OR abandon\*) AND (information equivocal\*) into two databases, i.e., EBSCOhost (Business Source Elite, EconLit, PsycARTICLES and Psychology and Behavioral Sciences Collection) and SciVerse Scopus (subject areas includes Social Science & Humanities). Equivocality is associated with multiple interpretations, conveyed meanings or perceptions with regard to particular information. Indeterminacy of analyzed data, demand of “richer” or different types of information, and exchange of views and judgments to settle disagreement and reach consensus specify the emergence of equivocality. From that derived notion, we developed the concept of equivocal situations in the context of IS/IT project evaluations. We further defined equivocal situations in IS/IT project evaluations as the state when decision-makers or evaluators encounter a lack of clarity and confusion in deciding on the continuation of a project, which occurred due to lack of knowledge or the existence of diverse knowledge with regard to information surrounding the project, especially its past performance and future attainment. In our initial review of the literature, we found a limited number of studies in the context of IS/IT projects which directly describe the causes of equivocal situations; thus, we extended our analysis to other similar contexts. The review included a thematically iterative process and analysis [24] resulting in eight conceptually substantiated categories of causes of equivocal situations. Then, we delineated the initial definitions of the categories.

### 3.2 Instrument development

In the second stage, we identified extant measurements with similarities to our categories. We constructed a pool of candidate items with high content validity by considering our initial defined categories and the identified problems of equivocality. A category was conceived as a common denominator for items under its delineated definition. The existing items which were too context specific were adapted and reworded to ensure suitability with the domain of our study. We tried to word the items in a simple and straightforward and excluded jargon or potentially unfamiliar words. Then, we corroborated and enhanced our initial development of the measurements and items using seven in-depth interviews with experts from academia and practice [25], and ten semi-structured interviews with practitioners of four project case studies [26]. We opted for this action to ensure adequate content validity of the constructs and the items before further utilization. We invited experts from academia and practice who hold a doctoral degree (or a candidate) and/or have experience managing and evaluating IS/IT projects. For the project case studies, we invited practitioners who were involved in IS/IT project evaluations and decisions. A minimum of two participants is required per case to obtain different perspectives and sufficient triangulation among people within a group of decision-makers. In the interviews, we defined the equivocal situations and presented characteristics of equivocality in the context of IS/IT project evaluations. We asked the participants to recall a project with similar condition during its evaluation. We first allowed the participants to express their thoughts on the project and the evaluation; then we focused on the causes of the described condition. We provided our categories, their definitions and measurements afterwards. We asked them to comment on the categories and the measurements, and whether they could suggest additional issues or problems that cause such a condition based on their experience. Their suggestions served as input to modify the initial items. We further requested the participants to assess the degree to which they agree with the category of the causes and their importance on affecting the described condition (i.e., equivocal situation in project evaluation) using a 7-point scale (1 indicated a strongly disagreed/an unimportant cause, and 7 indicated a strongly agreed/an important cause).

One of the researchers transcribed and coded the interviews. The coding was then discussed with other researchers to gain additional perspectives. We consolidated our initial findings from the literature review with the results of the interviews. We redefined the categories and modified the items accordingly with the results of this stage. The aforementioned process was conducted to ensure content validity by selecting the right items for the construct based on the categories' definitions and the identified problems of equivocality. Eight categories of equivocal situation causes were established Table 1 provides definitions of the constructs and the supporting references as well as examples of quotations from qualitative studies.

Table 1. Developed constructs

Construct	References	Quotation from qualitative studies
<b>Complexity in process (CP):</b> <i>the extent to which the process of developing IS/IT involves substantial intricacy</i>	Brun and Saetre [27], Chang and Tien [28], Fazlollahi and Tanniru [29], Jones and Kydd [30], Koufteros, et al. [31], Lim and Benbasat [32]	"...[the situation] was actually [occurred because] the [number] of stakeholders is too big to organize in that certain time limit..."
<b>Sophistication of technology (ST):</b> <i>the extent to which the design of the IS/IT product or solution is considered innovative or advanced</i>	Brun and Saetre [27], Fazlollahi and Tanniru [29], Kydd [33]	"...there is no other project that [is] comparable with our project in [the] whole [region] based on [the theme]..."
<b>Challenges in project management (CPM):</b> <i>the extent to which the IS/IT project encounters substantial management challenges</i>	Mähring and Keil [22], Jones and Kydd [30], Kydd [33], Hantula and DeNicolis Bragger [34], Levander, et al. [35], Pan and Pan [36]	"...I made several attempts [at] the [project] to make [the] goals more specific, there were quite [a few] reports about it, but it [did] not [really become] specific, no, it was still a bit [of a] vague project."
<b>Lack of standards (LS):</b> <i>the extent to which evaluators/decision-makers utilize evaluation criteria to ascertain the project value</i>	Bowen [8], Brun and Saetre [27], Chang and Tien [28], Fazlollahi and Tanniru [29], Jones and Kydd [30], Koufteros, et al. [31], Lim and Benbasat [32], Hantula and DeNicolis Bragger [34]	"...so there were no plans for uhm go-no-go for the project board... most of it was in the head of the project manager that time..."
<b>Changes in external state (CES):</b> <i>the extent to which the project is affected by organizational environmental dynamics</i>	Chang and Tien [28], Fazlollahi and Tanniru [29], Carson, et al. [37]	"...there are a lot of political pressures as well in the project [which] makes people quite nervous [be]cause of [the] political pressure..."
<b>Different frames of reference (DFR):</b> <i>the extent to which evaluators/decision-makers have diverse viewpoints when evaluating the project</i>	Fazlollahi and Tanniru [29], Jones and Kydd [30], Levander, et al. [35], Daft, et al. [38], Frishammar, et al. [39], Zack [40]	"...you have different stakeholders and different user groups.. and they have different [backgrounds]... So their evaluation is different..."
<b>Failure of evaluation methods (FEM):</b> <i>the extent to which evaluators/decision-makers apply techniques or tools to evaluate the projects</i>	Bowen [8], Tiwana, et al. [9], Keil and Flatto [41]	"No no nothing.. no no.. there was a zero method here... Yes [we have a certain method], just chose not to use it..."
<b>Lack of evaluation data/information (LED):</b> <i>the extent to which evaluators/decision-makers use data surrounding the project to support decision-making</i>	Bowen [8], Newman and Sabherwal [42]	"...there was an evaluation moment but there [were] really very [few] materials to make the, uhm, that you could use to make a decision..."
<b>Equivocal situation (ES):</b> <i>the extent to which evaluation of the project is hampered by equivocality</i>	Lim and Benbasat [32], Daft, et al. [38], Watts Sussman and Guinan [43]	"...equivocality means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation. Equivocality often means confusion, disagreement and lack of understanding." (from literature review)

### 3.3 Instrument enhancement

In the third stage, we employed two rounds of Q-sorting exercises to assess the convergent and the discriminant construct validity of the items. We followed the procedure set by Moore and Benbasat [23]. The procedure comprises a technique to specify the "hit" ratio, i.e., the desirable placement of items within different constructs or categories of causes. The technique is useful to assess and measure the construct validity. The result of the two rounds of Q-sorting exercises indicates reliability of the categorization and the items. Although some quantification can be made, the reliability and validity analysis of this procedure should be seen as being more qualitative instead of purely quantitative

[23]. WebSort/OptimalSort online card sorting was used to conduct the sorting exercises (Fig. 2). The website has features to conduct the sorting exercises remotely and simultaneously and to download the raw data swiftly (<http://www.optimalworkshop.com/optimalsort.htm>). The website also provides useful outputs such as dendrogram (Fig. 3) and popular placements matrix. Different sets of participants were used in the two-rounds of sorting exercises. The participants in the first round consisted of four master students (unfamiliar with the research topic) and the second round had a combination of four doctoral students and faculty members (familiar with information systems field but not with the research topic specifically).

Prior to the exercises, we introduced our research briefly and described the objectives of the exercise. Then, the participants opened the website using their internet browsers and read the instructions. We clarified the instructions further, when necessary; when ready, we asked the participants to proceed with the exercises. The participants were provided with the categories, including one labeled “Indecisive” for ambiguous and indeterminate items, and they had to sort or group the randomized-items into the categories. The exercises lasted 20 to 30 minutes on average for each participant. We discussed the sorting experience with the participants after the exercises; specifically, the categorization and the items within the “Indecisive” category. We collected and analyzed the data from the first round before continuing with the second round. We constructed a matrix and calculated the inter-judge agreement levels, the computed Kappas and the “hit ratios”. The averages in the first round were: “hit ratios” 68%, raw agreement 69%, and Kappa 64%. Furthermore, we examined the remarks and suggestions from the participants, and highlighted several points to improve the items. For example, negative and positive expressions seemed to influence the participant decision to put items into particular categories. We made several revisions by rewording the items to fit the intended category better, especially items that were frequently misplaced and deemed as ambiguous or indeterminate. Several candidate items which were often put into more than one category were revised as well. Several items were flagged because of their potential lack of distinctiveness and convergence, for instance the item “*several of the decision-makers who evaluate the project have switched a few times*”.

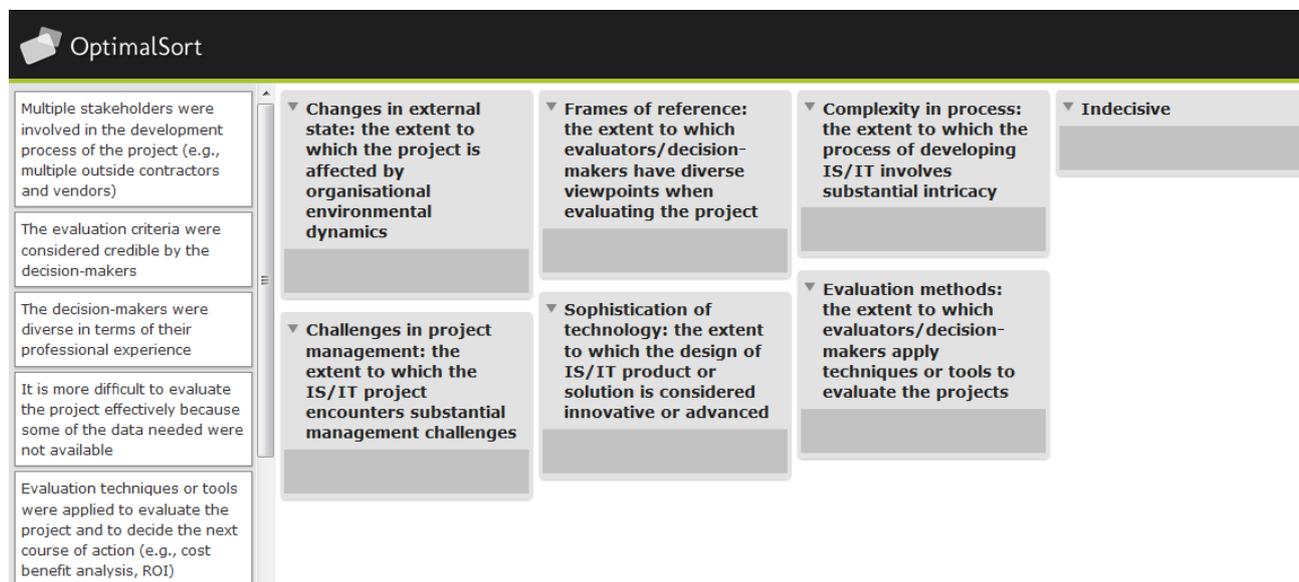


Fig. 2. Q-sorting exercise panel

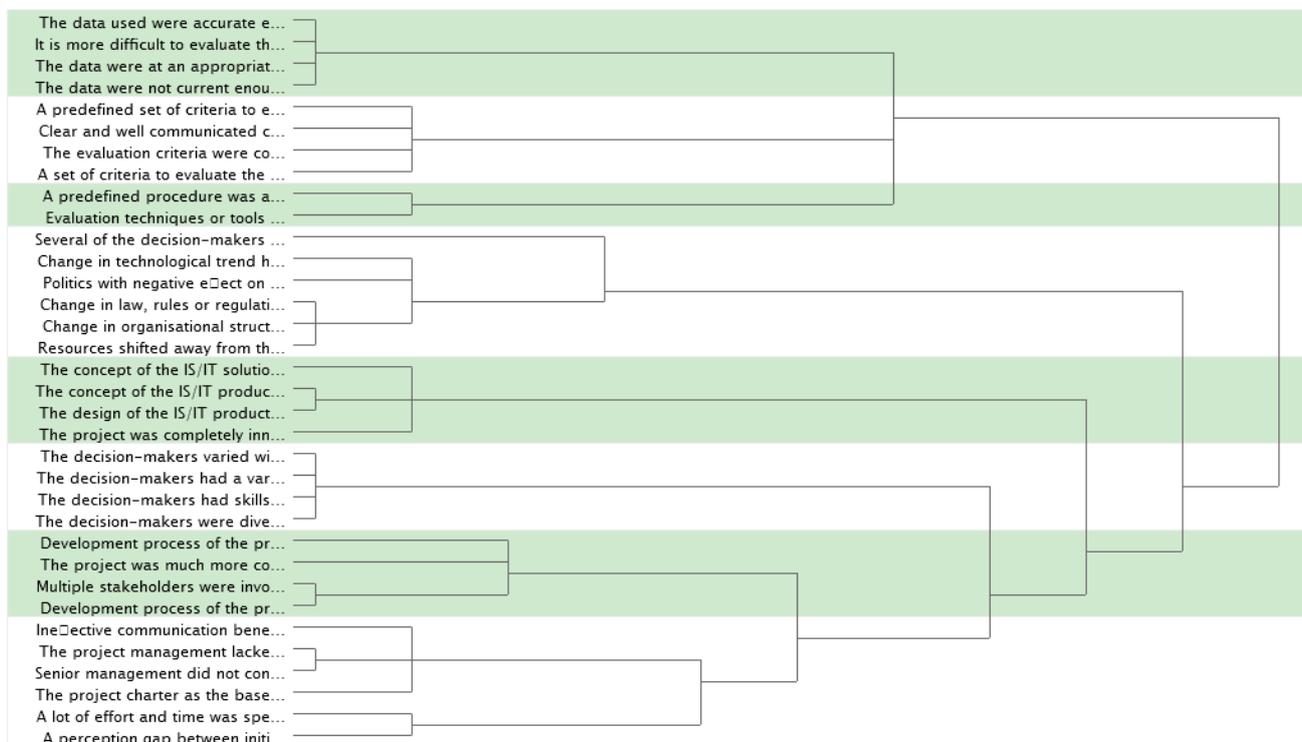


Fig. 3. Q-sorting exercise output (dendrogram)

The final modifications were employed in the second round. We repeated the calculation to measure improvement after the modification. The construct averages in the second round were: “hit ratios” 86%, raw agreement 85%, and Kappa 83%. The percentage of items placed in the target constructs were high, showing reliability of the items, which suggests the items tap adequately into the respective constructs. The overall result indicates an improvement of convergent and discriminant construct validity of the items as well as an achievement of appropriate levels of agreement, i.e., a Kappa value higher than 0.6 and a placement ratio higher than 0.8 [23]. In addition, we reconsidered the flagged items and items which seemed redundant conceptually or semantically. Table 2 provides a summary of the agreement measures for both rounds. Table 4 provides the candidate items used to measure the developed constructs. Based on the overall improvement of the items, we considered the measurement to be adequately valid for the next stage, i.e., application of the instrument. We then composed a draft of the survey based on the Q-sorting result.

Table 2. Inter-judge agreements

Agreement Measure	Combination	Round 1	Round 2
Raw agreement	1 and 2	0.71	0.90
	1 and 3	0.68	0.81
	1 and 4	0.66	0.85
	2 and 3	0.71	0.82
	2 and 4	0.69	0.91
	3 and 4	0.66	0.81
Average		0.69	0.85

Table 3. Inter-judge agreements (cont.)

Cohen's Kappa	1 and 2	0.67	0.88
	1 and 3	0.63	0.78
	1 and 4	0.61	0.82
	2 and 3	0.67	0.80
	2 and 4	0.65	0.90
	3 and 4	0.61	0.78
Average		0.64	0.83
Placement ratios summary			
Complexity in process (CP)		0.44	0.81
Sophistication of technology (ST)		0.50	0.94
Challenges in project management (CPM)		0.65	0.71
Lack of standards (LS)		0.67	0.88
Changes in external state (CES)		0.75	0.85
Different frames of reference (DFR)		0.85	0.85
Failure of evaluation methods (FEM)		0.63	0.88
Lack of evaluation data/information (LED)		0.94	1.00
Average		0.68	0.86

It is important to note the way equivocal situations were measured. The items were synthesized from the initial literature review by considering the extant studies listed in Table 4. The construct consisted of four candidate items which had more complex syntaxes and seemed to be double-barreled. Double-barreled expressions are commonly avoided in item creation since they might be considered psychometrically inadequate. This reason mainly arises from the difficulty to precisely pinpoint which facets respondents refer to and the difficulty to describe how respondents combine all the facets when generating their responses [44, 45]. However, longer and more complex syntaxes as well as multiple terms (or barrels) in one item have been used in certain cases. For example, [46], [43], and [47] use items which are relatively longer, more complex, and contain multiple items to assess new service development (NSD) culture (“*Our firm emphasizes its human resources and places a premium on high cohesion and morale in its new service development activities*”), task ambiguity in software development projects (“*During system development, to what extent can information be interpreted in different ways, which can lead to different but acceptable solutions?*”), and top management involvement in new product performance (“*Individuals and teams settled their own disputes and came up with ways to reconcile differing views or opinions that developed*”). In these cases, the items might appear to be double or multiple-barreled; however, they are usable because [45]: (1) the use of multiple terms in one item can be interpreted as one united idea; (2) particular items may require multiple terms for the idea to make sense and thus have to exist together. The use of multiple terms works as long as it does not make the main idea of an item confusing [45].

We consider equivocal situations as relatively complex conditions and since the studies which explore and examine equivocal situations in the context of IS/IT project evaluation are still limited it is important to define and construe the idea into these candidate items although they become seemingly longer and complex. In our case, when assessing whether the level of an equivocal situation was high or low, it is merely a concern whether the respondents considered only a particular facet existed or all the described facets existed together to a great extent or did not exist at all in the items.

Table 4. Candidate items

Item		Reference
CP1	Multiple stakeholders were involved in the development process of the project	Perceived complexity in software development [43].
CP2	The development process of the project involved a lot of integration with other systems	Information systems development project (ISDP) complexity [48]. Project complexity in new product development [49].
ST1	The concept of the IS/IT product was very novel	Concept complexity and novelty in the new product development [50].
ST2	The design of the IS/IT product involved the use of immature technology	Project complexity in software project risks [51, 52]. Innovation in black swan IS/IT projects [53].
CPM1	The project had NOT set out project milestones adequately	Project planning and project monitoring & control in software projects [54].
CPM2	Senior management did NOT control the project adequately in order to keep it on track	Requirement diversity in information systems development project [55-57].
CPM3	Ineffective communication among people in the project management structure	Project management in new product development project [58].
CPM4	The project charter, as a basis for managing the project, was vague	
LS1	Clear and well communicated criteria for go/no-go decisions and significant resource adjustments were set by the decision-makers (reverse)	Decision-making clarity in innovation projects [58].
LS2	The evaluation criteria were considered credible by the decision-makers (reverse)	Formal evaluation system in innovation projects [50].
LS3	A set of criteria to evaluate the project was agreed by the decision-makers (reverse)	Credibility and efficiency in innovation project proposal screening [59].
CES1	Changes in law, rules or regulations had a significant impact on the project	Organizational environment in software projects' risks [51, 52, 60].
CES2	Changes in organizational structure external to the project had significant impact on the project	Environmental volatility in new product development [47].
CES3	Politics had a negative effect on the project	
CES4	Resources were shifted away from the project because of changes in organizational priorities	
DFR1	The decision-makers had different backgrounds	Team diversity in software development agility [61].
DFR2	The decision-makers had skills and abilities that complement each other (reverse)	Senior team heterogeneity [62].
FEM1	A predefined procedure was applied to evaluate the project and to decide the next course of action (reverse)	Formal evaluation system in innovation projects [50].
FEM2	Evaluation techniques or tools were applied to evaluate the project and to decide the next course of action (reverse)	
LED1	The data used were accurate enough to evaluate the project (reverse)	Information systems users' satisfaction with the data [63].
LED2	It is difficult to evaluate the project effectively because some of the needed data were NOT available	Data quality in ERP implementation [64].
LED3	The data were at an appropriate level of detail to evaluate the project (reverse)	

Table 5. Candidate items (cont.)

Item		Reference
ES1	The project status or condition was hard to ascertain due to different interpretations among decision-makers of information surrounding the project	Environmental ambiguity in new product development [47].
ES2	Decision-makers lacked clarity and understanding of the condition of the project and thus were confused concerning the next course of action	Ambiguity in software development [43].
ES3	It was problematic to analyze the condition of the project since insufficient objective data was available to base the decisions on	Information equivocality in organizational work units [65].
ES4	Decision-makers needed to exchange opinions, share meanings and beliefs toward the project to settle disagreement and reach consensus for the next course of action	Perceived equivocality in text-based and multimedia representation [32].

### 3.4 Instrument preparation

In the fourth stage, we created a draft of an invitation letter and developed an online survey based on the draft questionnaire. A feature of the online survey was prepared to monitor the distribution and to capture the response data of the respondents. We tested the online survey on colleagues from academia who have knowledge of the IS/IT field via a survey link. Each person went through the questionnaire and made remarks and suggestions after completion. Several of the remarks were mostly related to the flow of the questions and the estimated time to complete the survey. Notes were taken during the discussion to improve the easiness and the clarity of the questionnaire further. The questionnaire was comprised of two parts: the first part encompassed the questions used to investigate the equivocal situations and their causes as well as the decisions and the actual implementation of the projects; the second part questioned the respondents about themselves and their chosen projects. The questionnaire asked the respondents to recall a recent review or evaluation of a challenged IS/IT project they were involved in and to keep this one project in mind throughout the questionnaire. We mostly employed the 7-point Likert scales that typically range from (1) Not at all and (7) To a great extent, for each of the measurements. On acquiring the remarks and suggestions, several refinements were made to improve the survey, such as recasting the survey's main and section openings as well as adding questions related to the project and the respondent profile. We collected the responses of the pilot test after (1) sending an invitation to personal contacts; (2) sending and posting the invitation to several relevant LinkedIn groups; and (3) requesting IS/IT professional organizations to partake in our survey. Around 60 people had access to the survey and 33 respondents filled the survey in completely within two weeks, in November 2013.

We created a straightforward path model between equivocal situations and the categories of causes, giving a one-level relation. Each candidate item serves as a formative indicator of the eight categories of causes (the first-order constructs) since it represents a problem of equivocality, developed inductively from the prior stages, i.e., literature review and qualitative studies [66]. Each category of causes is conceived as a composite construct that pulls together different facets of equivocality problems under a common denominator; thus each category is expected to be affected by the items or indicators [66, 67]. It is also important to note that the items within each category cannot have the same number since they are uniquely identified from the prior stages. Moreover, we consider the equivocal situation (ES) as a reflective construct since the items are a manifestation of the construct and are interchangeable [68]. The eight categories of causes are posited to have a positive association with the degree of equivocal situation in IS/IT project evaluation. Eight categories of causes serve as the independent variables and the degree of equivocal situation serves as the dependent variable. Fig. 4 presents the proposed research model. We further assessed the instrument based on the data acquired in this stage using SmartPLS 2.0 (M3) [69].

Unidimensionality of the construct of equivocal situation with reflective indicators is required to show validity and reliability. Unidimensionality is tested using Cronbach's alpha with a threshold of 0.7 [70, 71]. The conditions for convergent validity to be met are shown by three aspects: (1) the indicator loadings for all items are significant and fulfill the 0.7 threshold; (2) the average variance extracted (AVE) fulfills the 0.5 threshold; and (3) the composite reliability score fulfills the 0.7 threshold [70, 71].

All the values of equivocal situations (ES) construct exceed the required threshold. The result shows the measurements were good quality. Furthermore, multicollinearity is a threat to the eight causes of equivocal situations using formative indicators. Multicollinearity is examined by inspecting the variance inflation factor (VIF) values, which should not exceed 3.3 [70-72]. The maximum variance inflation factor (VIF) for this test was 2.72. This suggests multicollinearity is not a problem. We further checked the correlations between the constructs; these were below the suggested 0.71 threshold [73], which suggests limited information concerning discriminant validity of the constructs [73]. Thus, we developed the application based on the described assessment further by adding respondents to increase the sample.

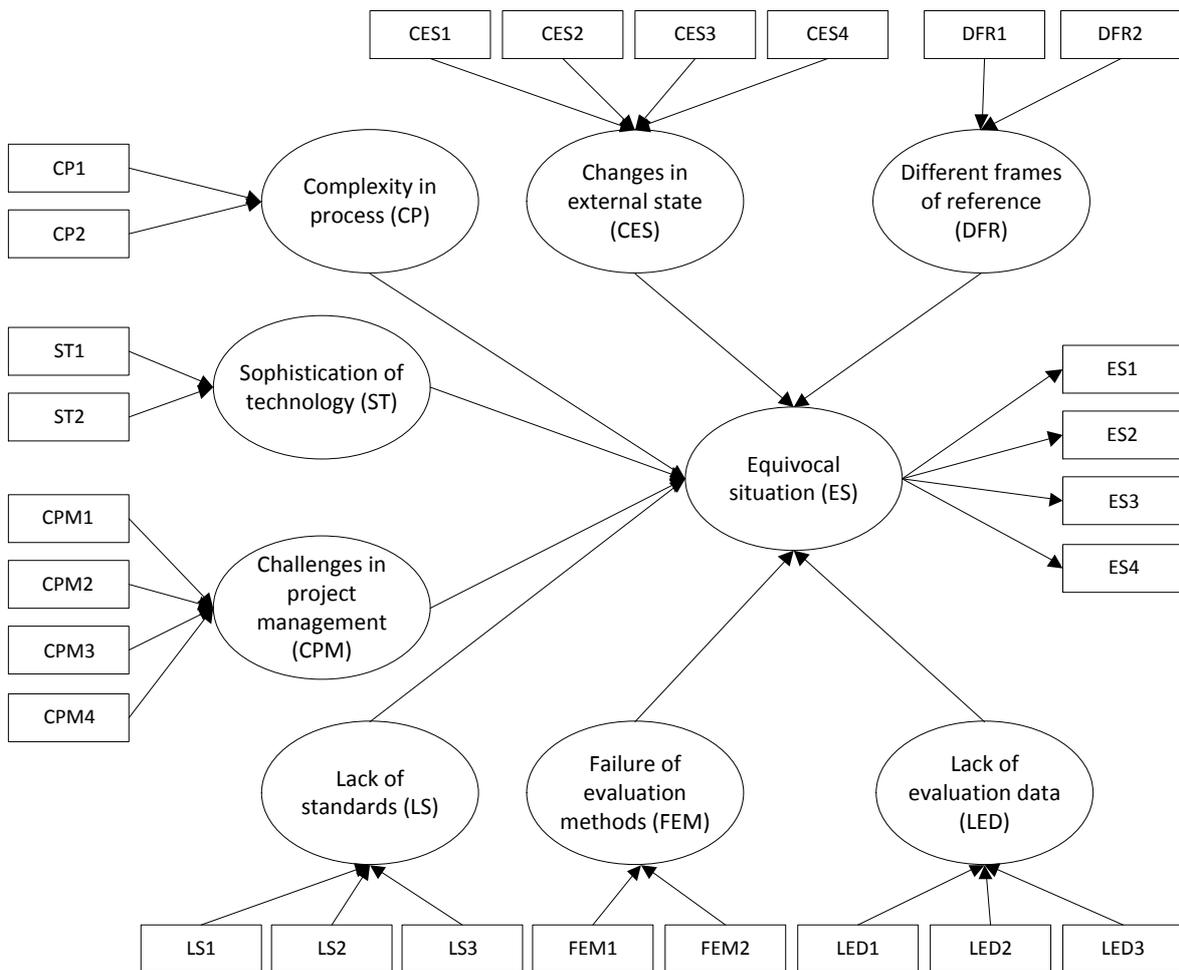


Fig. 4. Formative model of the causes of equivocal situation

### 3.5 Instrument application

In the fifth stage, we collected more data in a similar way to that described before, to acquire relatively quick responses and to keep the costs low. Two IS/IT professional organizations helped with our data collection by publishing the survey invitation on their website and sending it via newsletters. A total of 111 respondents partook in our survey within a period of seven months (January-July 2014). The profiles of the respondents can be described as follows: senior managers of IS/IT or CIO (23%), project managers (21%), IS/IT managers (19%), and the rest includes non-senior or non-IS/IT managers and other roles such as consultants, auditors, etc. The top three sectors in which the respondents worked were banking (financial) (16%), IT services (14%), and Government (13%). More than half of the respondents (52%) worked in a larger than average organization/industry.

Moreover, the profiles of the projects could be described as follows: the primary purposes are mostly strategic systems (19%) and business transformation (19%). The types of projects were: packaged software implementation (35%); in-house new development (30%); and enhancement of existing software/systems (15%). 69% of the projects were considered larger and 70% were of longer duration than other IS/IT projects undertaken by the organizations. Concerning the decision of evaluation, 18% of the projects had suffered total and substantial abandonment. 51% of the projects were categorized as escalated, and another 26% of the projects were proceeding as planned. Around 40 percent of the projects were considered as not being over budget, 23% as not behind schedule, and 32% as not lacking requirements or required specifications.

We continued to utilize PLS with SmartPLS 2.0 (M3) [69] since it suited the nature of our study. This is a theory-building study and at an early stage we attempted to define the equivocal situations and to identify the causes and thereby to develop an instrument to measure them. The proposed research model, which includes a mix of reflective and formative measures, is also well suited to a PLS analysis [74]. We ran the PLS algorithm to re-examine the model. Regarding the reflective items, the ES4 had a loading below 0.7 (0.55); thus, we decided to drop the item. On doing so, the conceptual domain of the construct still remain intact given that reflective items are interchangeable [68]. Table 6 provides the loadings of the reflective items and the quality criteria of the reflective measure for the equivocal situation construct. We developed a matrix of latent variable correlations (Table 7) and generated the values of variance inflation factor (VIF) for the formative items (Table 8).

Table 6. Loadings and quality criteria for reflective measure

Construct	Item	Standardized Loading	AVE	Composite reliability	Cronbachs Alpha
Equivocal situation (ES)	ES1	0.81	0.67	0.86	0.75
	ES2	0.85			
	ES3	0.79			

Table 7 shows that none of the correlations are above 0.90 and below 0.71 [73]. The maximum variance inflation factor (VIF) is 2.69. There are two types of VIF in Table 8, i.e., the outer and inner VIF. The outer VIF shows the severity of collinearity among items within a construct; additionally, the inner VIF shows the severity of collinearity among constructs (latent variables) in the model [75]. Overall, the value of the VIF suggests that multicollinearity is not a threat in our study as might be suggested by a more restrictive VIF threshold, i.e., a value of 3.3 [70-72]. Table 8 also provides the weights, the outer loadings, and the statistical significance of the formative items. The weights of the items show the relative importance or contribution, and the relevance of the items to the corresponding constructs [75]. More than half of the weights of the items reported here are not significant; however, this does not indicate a poor instrument [75]. The outer loadings, which show the absolute importance or contribution of items to the corresponding constructs, are significant except for the CP1, ST2, and CES1 [75]. We opted to retain the three items this time despite less empirical support of their relevance. This was done to avoid compromising content validity of the constructs since the items stemmed from the prior qualitative studies.

Moreover, the ST2 and CES1 are negative but the correlations between items in the CES and ST constructs are all positive. Co-occurrence of negative and positive item weights may occur when a suppressor effect is involved [67]. High correlations occurred between ST1-ST2 (0.33) and between CES1-CES4 (0.33). The magnitude of the correlations among these formative items may invert the signs of these items [67]. The negative figures can be interpreted as: when all other items being equal, increased amounts of ST2 or CES1 reduce the degree of the corresponding constructs (i.e., ST and CES) [67]. Fig. 5 exhibits the proposed model with the item weights. The figure shows the weights for each item and their significance; however, it does not display the path coefficients and the coefficient significances. We limited the assessment to the formative and reflective measurement model since this is the primary objective of the paper. An assessment of the structural model is outside the scope of this paper.

Table 7. Latent variable correlations

	<b>CES</b>	<b>CP</b>	<b>CPM</b>	<b>DFR</b>	<b>ES</b>	<b>FEM</b>	<b>LED</b>	<b>LS</b>	<b>ST</b>
<b>CES</b>	-								
<b>CP</b>	0.29	-							
<b>CPM</b>	0.25	0.17	-						
<b>DFR</b>	0.24	0.18	0.36	-					
<b>ES</b>	0.36	0.20	0.58	0.42	-				
<b>FEM</b>	-0.09	-0.10	0.28	0.30	0.22	-			
<b>LED</b>	0.34	0.08	0.42	0.22	0.51	0.12	-		
<b>LS</b>	0.14	0.04	0.43	0.48	0.41	0.61	0.33	-	
<b>ST</b>	0.13	0.19	0.09	-0.02	0.19	-0.22	0.12	-0.11	-

Table 8. Variance Inflation Factor (VIF) and weights for formative measures

<b>Construct</b>	<b>Item</b>	<b>Outer VIF</b>	<b>Inner VIF</b>	<b>Weight</b>	<b>Outer loading</b>
Complexity in process (CP)	CP1	1.06	1.17	0.17	0.39
	CP2	1.06		0.95***	0.99***
Sophistication of technology (ST)	ST1	1.12	1.12	1.05***	0.97***
	ST2	1.12		-0.26	0.09
Challenges in project management (CPM)	CPM1	1.46	1.48	0.31**	0.75***
	CPM2	1.44		0.48***	0.79***
	CPM3	1.44		0.15	0.65***
	CPM4	1.27		0.42***	0.71***
Lack of standards (LS)	LS1	1.96	2.10	0.04	0.71***
	LS2	2.53		0.58*	0.95***
	LS3	2.69		0.46	0.92***
Changes in external state (CES)	CES1	1.13	1.29	-0.11	0.23
	CES2	1.24		0.11	0.51**
	CES3	1.13		0.11	0.39*
	CES4	1.33		0.94***	0.98***
Different frames of reference (DFR)	DFR1	1.00	1.41	0.41**	0.45**
	DFR2	1.00		0.89***	0.91***
Failure of evaluation methods (FEM)	FEM1	2.73	1.75	0.73	0.98***
	FEM2	2.73		0.32	0.90***
Lack of evaluation data/information (LED)	LED1	2.10	1.38	0.02	0.47***
	LED2	1.26		0.97***	0.99***
	LED3	2.05		0.03	0.45***
Bootstrapping results (n = 5000) *Significant at the 0.10 level (two-tailed) **Significant at the 0.05 level (two-tailed) ***Significant at the 0.01 level (two-tailed)					

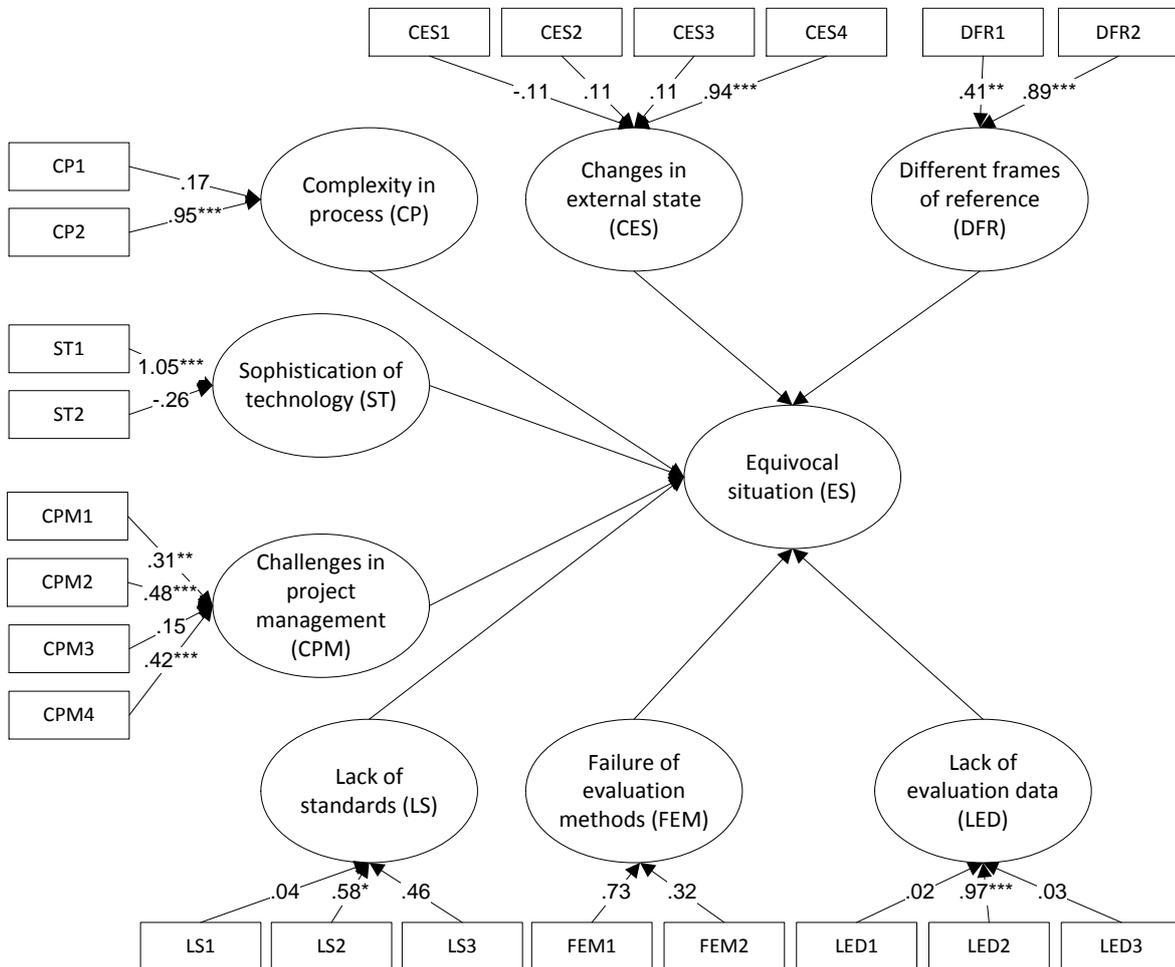


Fig. 5. Indicator weights of the model (N=111)

Furthermore, we utilized the importance-performance analysis by using a feature of SmartPLS 3.0 [76]. The matrix provides the impact of each distinct cause of equivocal situation on the equivocal situation construct (ES) and is a priority map for organizations to provide extra consideration and concentration to different areas of project management. The matrix plots potential causes which warrant improvement. Fig. 6 visualizes the relative performance and importance among causes of equivocal situations. To lessen the level of an equivocal situation, consideration should be given to aspects of high importance and performance. In Fig. 6, the X axis represents the total effect or the importance of the causes based on the impact of the causes affecting the equivocal situation. The Y axis represents the performance of the causes. To illustrate this, four clusters of equivocal situation causes can be made from the figures based on the similarity of their importance. The CPM (first cluster), which lies on the left side of the matrix, is portrayed as being the most important cause. The first, the second, the third, and the fourth cluster have a distinct impact on the occurrence of an equivocal situation. Extra consideration should therefore be given to CPM. In our case, a high performance score (Y axis) means more room for further improvement.

Within a cluster, attention should also be given to causes with a high performance (Y axis). DFR, ST, and CP are the causes which could be improved further by the organization to lessen the amount of equivocality in the project evaluation. For instance, a problematic situation due to Different frames of reference (DFR) may be improved by ensuring the capability of each decision-maker to collaborate and proceed with effective evaluation (DFR2).

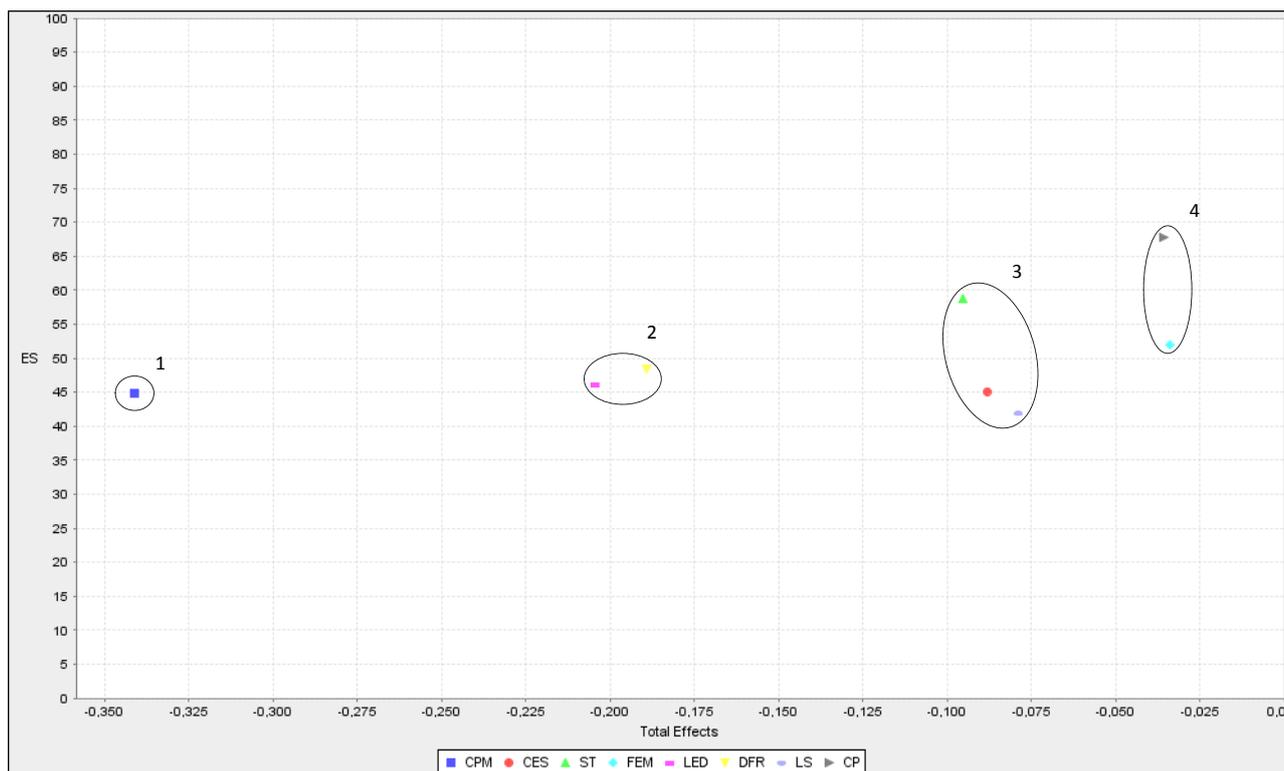


Fig. 6. Importance-Performance matrix

#### 4. Discussion and limitations

Despite the importance of equivocality in affecting the continuation of IS/IT projects, antecedents of equivocal situation are not well established. In this study, we describe the development and assessment of an instrument to define equivocal situation and eight causes of equivocal situations in the context of IS/IT project evaluation. The stages of the instrument-development process provide a meaningful instrument that has been assessed thoroughly. In the exploratory domain, we examine extant literature to provide insights into the notion of equivocality and its causes. During the instrument development, we employ a qualitative method to corroborate and improve the developed constructs and items. To further enhance the instrument, we utilize Q-sorting exercises. After a pilot test, we apply the instrument by acquiring responses from knowledgeable practitioners in IS/IT project management practice.

This study contributes to current research by means of the development and validation of instruments to measure equivocal situation and its causes in IS/IT project evaluation. This study offers a conceivable description and explanation of equivocal situation and the causes of such a situation via emerging issues associated with: the complexity

of the process used to develop the IS/IT, the sophistication of the technology being developed, the challenges met when managing IS/IT projects, the dearth of criteria used to evaluate IS/IT projects, the dynamics of the environments surrounding the projects, the divergence of the decision-makers' frames of reference, the failure of evaluation methods, and the lack of evaluation data to support decision-making. Moreover, this study is of practical relevance for practitioners: the availability of a usable instrument to gauge their IS/IT projects execution and evaluation, and to forestall the occurrence of an equivocal situation. The gained insight from this study does not mean that extra devotion should be given only to the causes which have a high impact on the occurrence of equivocal situation per se. The knowledge of how the causes emerge from different issues of project management and are then translated into problematic situations (i.e., confusion and dilemma) should be looked at and worked on in detail. It will make practitioners more aware and will stimulate them to be critical about their current practice.

Nevertheless, this study entails some limitations. First, the composition of the constructs and items derived from the literature review and qualitative studies may not be exhaustive. Likewise, the constructs do not contain equivalent numbers of items due to the way we identify and derive the problems of equivocality. To a certain extent, this may influence certain causes with large numbers of items, as the impact on an equivocal situation may be greater. Second, the way we model equivocal situation and its causes may not be definitive and the way we specify the constructs is debatable. One should consider and compare other possibilities to model the relations. Third, we do not consider the heterogeneity of our sample. This may have limited the accuracy of the PLS computation and the result.

## 5. Conclusion and further research

The purpose of this study was to develop and assess an instrument to measure equivocal situation and its causes. The study contributes to extant literature on IS/IT project management literature by establishing the concept of equivocality in IS/IT project evaluation, identifying the causes, as well as developing an instrument to measure them. Further examination of equivocal situation and its causes can be warranted by considering alternative or competing ways to model the equivocal situation and its causes in the context of IS/IT project evaluation. This includes the possibility to improve the current model by constructing a hierarchical component model (HCM) or higher-order constructs. For instance, the formative-formative type IV model could be developed. According to [77], "*the formative-formative type model can also be useful to structure a complex formative construct with many indicators into several sub-constructs*". This is also beneficial to reduce the number of competing causes that connect to the equivocal situation construct by arranging the causes into theoretically-supported categories or groups [75]. Analyzing the heterogeneous groups within IS/IT projects (e.g., different types of information systems or technology) and extending the nomological network of other constructs associated with equivocal situation (e.g., evaluation decision) can be warranted as well. Furthermore, as around 41 per cent of the respondents were willing to discuss their answers to the questionnaire further, it merits post-hoc analyses of relationships among the constructs and on how the respondents coped with equivocal situations.

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