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Critical success factors (CSFs) for integration of sustainability into construction project management practices in developing countries

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Abstract

This study looks at the critical success factors (CSFs) affecting integration of sustainability into project management practices of construction projects in developing countries. Having innovation diffusion theory as the theoretical point of departure, CSFs pertaining to the triple bottom line of sustainability (environmental, social and economic) were identified through a comprehensive review of literature. These were customised for the context of developing countries by conducting 16 semi-structured interviews and were presented in form of a conceptual model. The model was validated through a survey returning 101 completed questionnaires with partial least squares structural equation modelling (PLS-SEM) as the method of analysis. This study contributes to the field by presenting one of the first studies in its kind focusing on CSFs for integration of sustainability into project management practices for construction projects within the context of developing countries.

Keywords: Critical success factors; Sustainability; Project management; Integration; Developing countries; Construction industry

1. Executive summary

Sustainability concerns in delivering construction projects have come to the fore in advanced economies. Yet, developing countries have put economic development above meeting sustainability requirements. The need for economic growth in developing countries has fuelled a huge demand for construction projects, hence environmental concerns being overshadowed. Project managers in developing countries are still lagging in integrating the concept of sustainability into core practices of managing projects.

With this in mind, the primary objective of this study is twofold. First, the study aims at discovering the critical success factors (CSFs) to integration of sustainability into practices of project management in delivery of construction projects in developing countries. Second, the present study attempts to encapsulate the identified CSFs into a framework for delivery of construction projects through the lenses of innovation diffusion theory. To this end, a mixed method; 'sequential exploratory design' is utilised. CSFs to sustainable delivery pertaining to the triple bottom line of sustainability are identified through a comprehensive review of literature with a special focus on existing studies in developing countries alongside well-known publications and checklists. Identified CSFs are customised for the natural context of developing countries through conducting 16 semi-structured interviews with project managers. Considering the novelty of sustainable practices for projects in developing countries, CSFs are attributed to the requirements for adoption of an innovation

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on a project. The findings are validated through a survey questionnaire of project managers from Iran as a testbed of developing countries with 101 completed questionnaires. Accordingly, Partial Least Squares Structural Equation Modelling (PLS-SEM) is implemented to assess the strength of associations among different CSFs. The revised model in dialogue with innovation diffusion theory provides a framework that illustrates the most influential CSFs for developing countries.

The findings reveal that role of clients, knowledge management, high quality workmanship, strategic direction and health and safety protocols, project managers' knowledge, skills and abilities and tighter control over construction activities are the most influential CSFs. These CSFs are discussed in view of the identification, evaluation, commitment, preparation and implementation phases of sustainability integration into construction project management practices. The clear message is, integration of sustainability into project management practices will not occur in absence of support from policy makers. Besides, changes in clients' demands and a serious systematic enforcement of existing environmental regulations play a pivotal role in transition to a sustainable project management in developing countries.

This study contributes to the field by presenting one of the first studies on CSFs to sustainable delivery of construction projects within the context of developing countries. Based on an established theory namely innovation diffusion, the study findings incorporate perceptions of projects managers. As such, findings have implications for project governance in developing countries. That is, the findings assist integration of sustainability into practices of project management through presenting a number of CSFs which are customised and contextualised for the natural context of developing countries.

2. Introduction

The prevailing trend towards economic growth in developing countries has resulted in a huge demand for delivering construction projects (Zhang et al., 2014), which in turn has overshadowed sustainability concerns (Chang et al., 2016). Consequently, project managers in developing countries are lagging in embracing the concept of sustainability in managing projects (Abidin and Pasquire, 2007). Yet, sustainable construction has become the new 'Zeitgeist' in recent years (Zhang et al., 2014) with project managers worldwide including in developing countries being expected to deliver projects in a sustainable manner (Dobrovolskienė and Tamošiūnienė, 2016; Du Plessis, 2007; Ortiz et al., 2009).

To address such a challenge, Silvius et al. (2012) outlined the principles of sustainability to be integrated into practices of project management. Nevertheless, due to the sociocultural and economic idiosyncrasies of developing countries (Elkhalifa, 2016), context-specific critical success factors (CSFs) need to be developed to assist project managers (Gan et al., 2015; Othman and Ahmed, 2013; Pade et al., 2008). CSFs play a crucial role in enabling and smoothing the process of integrating sustainability into project management practices (Chang et al., 2016; Martens and Carvalho, 2017; Zhang et al., 2014). In essence, understanding the CSFs associated with sustainability is a prerequisite for integration of sustainability into project management practices for construction projects in developing countries (Pade et al., 2008). Nevertheless, integration of sustainability into project management practices has remained an overlooked area (Dobrovolskienė and Tamošiūnienė, 2016; Martens and Carvalho, 2016, 2017). In particular, a review of literature reveals a conspicuous absence of studies on identifying CSFs of sustainable delivery of construction projects in developing countries.

To address such a gap in the body of knowledge, the objective of this study is to discover the CSFs to integration of sustainability into practices of project management in delivery of construction projects in developing countries. The study encapsulates these identified CSFs into an integrated model through the lens of innovation diffusion theory as the theoretical point of departure.

The remainder of the study is organised as follows. First, the background to the research problem, the process of collecting CSFs from the literature and the innovation diffusion theory as the theoretical point of departure are discussed. Afterwards, the research methods and the design of the study are explained. Next comes presenting the findings of the study followed by a discussion on these findings. The study concludes with outlining the contributions of the study, acknowledging the limitations and suggesting future research potentials.

3. Research background

According to World Bank (2015), countries with Gross National Income (GNI) per capita of 12,475 USD or less are classified as developing countries. The human development report released by the United Nations (UN) indicates that around 85% of the world's population live in developing countries (Klugman, 2011). In view of such importance and to serve the primary objective of this study, concepts are discussed below with a focus on developing countries.

3.1. Sustainability/project management

In recent decades, the governments of developing countries have allocated substantial amounts of capital budgets to infrastructure, transportation and residential projects (Chang et al., 2016; Gan et al., 2015; Zhang et al., 2014). Construction projects in developing countries have profound impacts on communities, the environment and social features (Van Marrewijk et al., 2008) with an immense weight within the economy (Chang et al., 2016; Ghoddousi and Hosseini, 2012). The above facts underline the considerable importance of integration of sustainability into delivery of construction projects in such countries (Chang et al., 2016; Du Plessis, 2002).

Nonetheless, a wide range of challenges such as unstable economy, lack of data and transparency (Elkhalifa, 2016) and corruption affect the construction industry in developing countries (Othman and Ahmed, 2013; Perera et al., 2014). Added to these, lack of the formal education on sustainability,

financial and political constraints and sociocultural challenges impede the adoption of sustainability (Hakiminejad et al., 2015; Pade et al., 2008). Furthermore, the dearth of financial incentives and obstructive policies are among the challenges inherent to developing countries when it comes to the sustainable delivery of construction projects (Chang et al., 2016; Gan et al., 2015).

According to Othman and Ahmed (2013), the main challenges influencing the sustainable delivery of projects in developing countries come under five major groups. These are technical, human development, managerial, political and triple bottom line (TBL) with TBL referring to environmental, social and economic challenges. Of these, managerial challenges have been found to be the most influential (Othman and Ahmed, 2013). Of particular interest should be unsustainable project management practices, found to be among the major barriers to the sustainable delivery of projects (Dobrovolskienė and Tamošiūnienė, 2016; Martens and Carvalho, 2016, 2017).

Against this backdrop, available studies that outline the guidelines and checklists for integrating sustainability into project management practices such as the study by Silvius and Schipper (2014) come from developed economies. Developing countries have been forced to follow such guidelines (Mollaoglu et al., 2016) where due to the challenges as discussed, developing countries require context-specific agendas (Pade et al., 2008).

3.2. Integration of sustainability into project management practices

Integration of sustainability into project management practices is defined in this study in line with the definition proposed by Silvius (2013). This refers to the comprehensive and harmonised assimilation of social, economic and environmental principles (TBL of sustainability) into effective project delivery systems. For this study, factors associated with enhancing sustainability in construction projects delivery and project management practices were identified through a comprehensive review of literature. This resulted in a list of 332 factors extracted from previous studies. For the sake of brevity, this list is illustrated in Appendix A.

The 332 identified factors covered a wide range of areas associated with sustainability in the construction industry and project management. The next stage of review of literature is termed by Levy and Ellis (2006) as evaluating "the applicability of literature". Testing for applicability of literature entails assessing the outcome collated from previous studies and retaining only the pieces of information which are applicable to the objective of the study and support the theoretical arguments (Levy and Ellis, 2006). This resulted in creating a list 56 factors in view of the three criteria below. These criteria were defined to reflect the objective of the study and the context under questions (developing countries). Selected 56 factors were then regarded as potential CSFs (as hereafter mentioned) associated with the integration of sustainability into project management practices in developing countries as illustrated in Table 1.

(1) Applicability to developing countries,
(2) Applicability to TBL of sustainability and
(3) Relevance to project management practices.

3.3. Theoretical point of departure

Innovation is defined by Mahajan and Peterson (1985 p. 8) as "… any idea, object, or practice that is perceived as new by members of the social system …". For the construction context, Slaughter (2000) described an innovation as the actual use of a non-trivial alteration in terms of an enhancement in a system or working procedure that is new to the corresponding organisation. Sustainability is not a widely-experienced practice within the context of developing countries (Gan et al., 2015), thus is regarded as an innovative concept for the construction industry in these countries (Boons and Lüdeke-Freund, 2013). Integration of sustainability into management systems has to be treated as an innovation diffusion process (Tsoutsos and Stamboulis, 2005). Likewise, the integration of sustainability into project management practices of the construction industry in developing countries could be approached through the lenses of innovation diffusion theory (Johansson, 2012; Mollaoglu et al., 2016). Use of innovation diffusion theory to explain the course of developing and implementing new ideas will increase the capacity of construction companies to harness the advantages of innovative methodologies (Slaughter, 2000). Besides, this gives investigators and practitioners a powerful tool to predict behaviours, assess capabilities, identify influential variables and evaluate their impacts on the process of introducing an innovative method (Mahajan and Peterson, 1985). When it comes to identifying CSFs for an innovation in the construction context, use of the innovation diffusion theory is particularly beneficial as it brings structural clarity and facilitates establishing a hierarchical order for prioritising in decision making (Liu et al., 2016). In view of the arguments above, innovation diffusion was selected as the theoretical point of departure for this study and the basis for development of the conceptual model as discussed below.

3.4. Conceptual model

For the construction context, the primary stages associated with the integration of an innovation could be divided into five consecutive stages as suggested by Slaughter (2000). These are identification, evaluation, commitments, preparation and implementation. According to the theoretical lenses of the study, the extracted CSFs were to follow the same trend. As such, these CSFs affect the five stages. The nature of CSFs in each stage should be in line with the definitions provided by Slaughter (2000) for the factors affecting each stage. This resulted in creation of the conceptual model of the study as illustrated in Fig. 1.

As posited by Slaughter (2000), the identification stage is affected by the strategic objectives of the organisation, the regulatory environment surrounding the organisation and the support from key decision makers in identifying the benefits of an innovation. Even more, innovation integration in the construction context strongly depends on the policies put into

Table 1
Pool of potential CSFs extracted from previous studies.

No.	Potential CSFs	References																		
		(Songer and Molenaar, 1997) US	(Jefferies et al., 2002) Australia	(Chan et al., 2004) Hong Kong	(Duy Nguyen et al., 2004) Vietnam	(Belout and Gauvreau, 2004) Canada	(Fortune and White, 2006) UK	(Du Plessis, 2007) South Africa	(Ogunlana, 2008) Thailand	(Ahadzie et al., 2008) Ghana	(Taylor, 2008) Worldwide checklists	(Saqib et al., 2008) Pakistan	(Bakar et al., 2010) Malaysia	(Li et al., 2011) Singapore	(Tabish and Jha, 2011) India	(ISO, 2012) Worldwide checklists	(Silvius et al., 2012) Worldwide checklists	(Gudienė et al., 2013) Lithuania	(Yong and Mustaffa, 2013) Malaysia	(Ihuah et al., 2014) Nigeria	(Liu et al., 2016) China
1	Knowledge and awareness of sustainable project delivery in the Project Management Team (PMT)																			✓	
2	Dominance of constructive relationships within project stakeholders								✓												✓
3	Implementing an effective strategic planning regime		✓		✓																
4	Emphasis on high quality workmanship								✓										✓		
5	Strong commitment to sustainable project delivery from project stakeholders													✓						✓	✓
6	Client's commitment to the needs of the other stakeholders			✓						✓											
7	Compliance with anti-corruption rules and regulations in the decision-making process													✓	✓						
8	Project managers leadership style											✓						✓	✓		
9	Needs assessment of people							✓													✓
10	Public acceptance towards the project																		✓		
11	Economic and Political stability		✓										✓								
12	Positive organizational culture in support of sustainable project management								✓									✓			✓
13	Enacting required policies in supporting sustainability principles establishment in construction projects by governmental and professional bodies										✓										
14	Clearly defined goals and prioritize of all stakeholders							✓										✓	✓		
15	Strategic alignment of project goals with stakeholders' needs								✓												
16	Comprehensive contract documentation				✓				✓				✓								
17	Well-defined scope of work and project constraints	✓													✓				✓		
18	Effective tendering method			✓															✓		
19	Project manager's experience and competence						✓	✓				✓						✓			
20	Availability of resources (fund, machinery, materials, etc.) as planned throughout the project				✓		✓								✓						
21	Multidisciplinary/competent project management team				✓								✓							✓	
22	Transparent and competitive procurement process										✓								✓		
23	Creating accountabilities, expectations, roles and responsibilities for the organization								✓												
24	Support and cooperation of Project Management Team (PMT) in delivering a sustainable project													✓	✓				✓		
25	A high degree of trust within the PMT		✓						✓						✓				✓		
26	Effective and open share of knowledge among PMT																				✓

27	Commitment to systematic methodologies of project management						✓		✓											
28	Adaptability to amendment in project scope														✓				✓	
29	Implementing an effective decision making process by the PMT						✓											✓		
30	Implementing an effective quality control and quality assurance regime									✓									✓	
31	Implementing an effective project monitoring and feedback methodology							✓												✓
32	Deploying updated and realistic project cost and time estimates by the PMT												✓							✓
33	Implementing an effective project risk management by the PMT	✓																		✓
34	Implementing an effective change management system						✓		✓											
35	Implementing effective communication and data exchange protocols at all levels of decision-making within the PMT			✓				✓												
36	Use of lessons learnt in previous projects by the PMT				✓		✓													
37	Effective allocation of resources	✓	✓																	✓
38	Implementing effective health and safety protocols by the PMT									✓	✓									
39	Use of up to date construction technology and methods for execution of the project								✓											
40	Environmental impacts management by the PMT		✓							✓										
41	Water and noise pollutions minimization										✓									
42	Waste management										✓									
43	Support of client's team for sustainability			✓		✓														
44	Top management support						✓		✓						✓				✓	
45	Effective management of changes in the scope of work during construction			✓											✓					
46	Effective use of facts and data to support actions at all levels of decision-making								✓											
47	Effective Project Control					✓							✓							
48	Continuing involvement of stakeholders in the project								✓										✓	
49	No social and political interference			✓											✓					
50	Absence of bureaucracy from the work place				✓				✓								✓			
51	Community involvement		✓		✓			✓												
52	Transparency in the procurement process																		✓	
53	Competitive procurement			✓															✓	
54	Comprehensive pre-tender investigation on project														✓				✓	
55	Providing adequate design details and specifications													✓					✓	
56	Regular quality control and quality assurance activities														✓	✓				

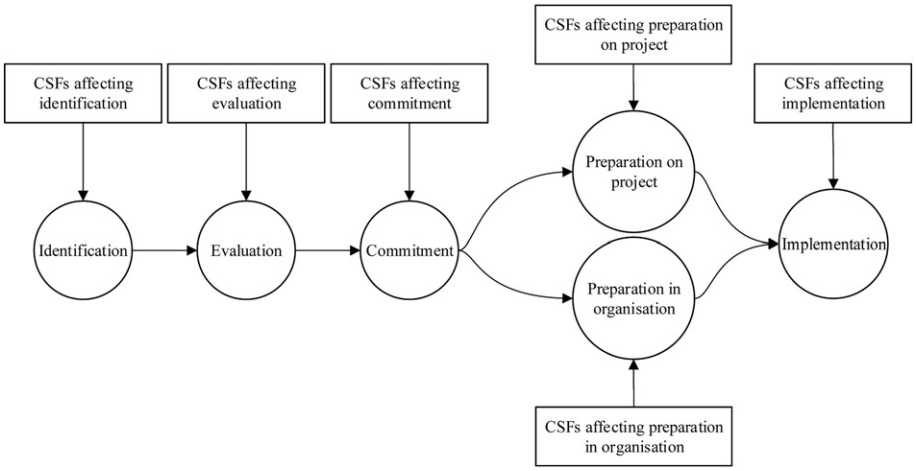

Fig. 1. Conceptual model of the study.

effect by the government (Aouad et al., 2010). As such, CSFs having these attributes are the CSFs affecting the identification stage as illustrated in Fig. 1.

Subsequent to identification, approval for integration of any innovation requires project managers to evaluate the advantages and risks (Bhatt and Ved, 2013). They should deploy decision making methodologies to effectively evaluate available alternatives of an innovation (Slaughter, 2000) and assess the difficulties and the benefits associated with it (Au and Enderwick, 2000). CSFs associated with these concepts are identified as the CSFs affecting the evaluation stage.

The next stage in the integration of an innovation is commitment which is influenced by the outcome of evaluation of the innovation and includes the organisation's/project's commitment to the innovation and allocation of essential resources. A number of CSFs affect the commitment stage and are associated with it. Preparation then refers to all activities geared towards preparing. A major focus at the preparation stage would be on having the team and skilled personnel in place with adequate knowledge to facilitate implementing the innovation (Slaughter, 2000). This occurs at two levels comprising in the organisation as well as on the project (Murphy, 2014). As a result, CSFs affecting preparation come in two groups. Those affecting preparation at project level and the others that affect organisation preparation activities. A key aspect of implementation would be managing the required change in processes and revising the procedures in order to increase the level of benefits obtainable out of implementing the innovation (Slaughter, 2000) with a number of CSFs affecting this stage.

Arranging CSFs based on the stage on which they were influential and following the sequence outlined by the innovation diffusion process to delineate these stages, engendered the conceptual model of the study as illustrated in Fig. 1.

4. Research methods

As discussed, the overarching aim of this research study is to unearth the CSFs affecting the integration of sustainability into project management practices on construction projects. It is essential to understand the perceptions of project managers with regard to the integration of sustainability into the practices they use (Ebbesen and Hope, 2013). That is because, project managers stand at the centre of selecting measures for delivering projects with a great influence on project stakeholders (Robichaud and Anantatmula, 2010). Project managers should consider sustainability as another success criterion alongside the iron triangle (time, cost and scope), if sustainability is to be integrated into the practices they utilise (Ebbesen and Hope, 2013). CSFs will be of the highest practical influence if the critical factors for integrating sustainability in delivering projects are explored through the lenses of project managers (Robichaud and Anantatmula, 2010).

Available options for collecting data from respondents are qualitative, quantitative or a combination of both using mixed-methods (Creswell et al., 2003). Of these, the mixed-methods approach is regarded as the most effectual for conducting research in the fields of management and organisational studies as argued by Creswell et al. (2003). As illustrated in Fig. 2, the design of the mixed methods approach for this study followed the *qual→QUAN* design. This was comprised of conducting a preliminary qualitative-driven study to serve and enhance the findings of a subsequent quantitative approach (as the primary method), which was termed by Creswell et al. (2003) as "sequential exploratory design".

4.1. Stage 1 (qualitative meta-analysis)

In order to conceptualise and synthesise the existing body of knowledge of CSFs for the construction industry, the qualitative meta-analysis approach was applied to collect appropriate publications and professional standards (Sandelowski and Barroso, 2006). The keywords used to explore the literature were *critical success factors*, *construction industry*, *project management practices*, *sustainable construction*, *sustainable project management* and *sustainable development*. Applicable publications were identified through

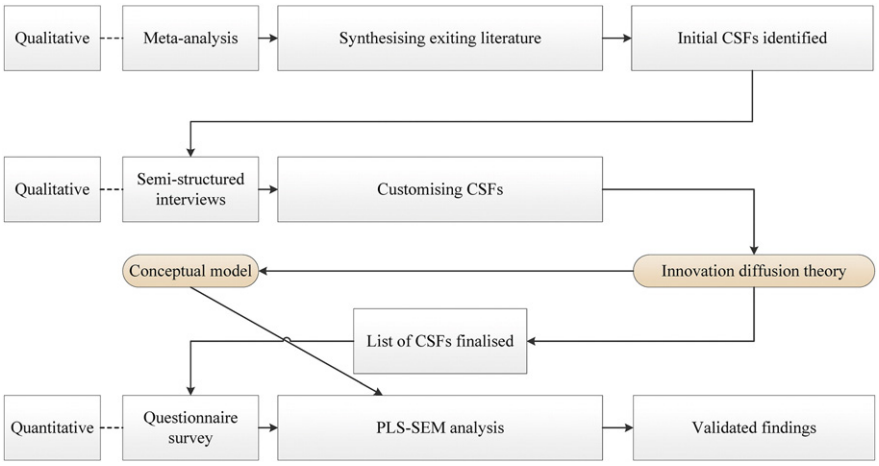

Fig. 2. Research design (sequential exploratory design).

screening the title/abstract/keyword within major databases including ScienceDirect®, ASCE®, Google Scholar®, etc. The abstract and introduction sections of the selected documents were subsequently analysed by the research team and applicable items (fitting clearly with at least two of the keywords) were retained. More than 30 relevant publications, checklists and standards were identified to form the foundation to create the initial pool of CSFs for further refinement. These CSFs are illustrated in Table 1.

4.2. Stage 2 (interviews)

This stage covered the customisation of the preliminary list of identified CSFs in stage 1 within the context of developing countries (matched with TBL of sustainability) through conducting semi-structured interviews with experts. To single out potential interviewees, the 'purposive sampling' strategy was used (Bazeley, 2013). Targeted interviewees included professionals with adequate experience in managing construction projects in which sustainability practices were adopted alongside academics with extensive experience in conducting research on sustainability in the construction field. In total, 27 experts were invited by phone or email out of which 16 experts agreed to participate in the study as illustrated in Table 2. The sample was deemed representative of a rich variety of expertise. Interviews were conducted from August to October 2015 with all the interview sessions recorded. Having 16 interviewees was deemed to provide an acceptable sample size according to Bertaux (1981), who maintained that 15 interviews is the minimum acceptable for qualitative studies.

4.3. Stage 3 (PLS-SEM)

The Iranian construction industry was deemed an appropriate context for exploring the CSFs for integration of sustainability into the project management practices for developing countries. This decision was made based on considering several features as discussed below.

According to Pournader et al. (2015), the amount of investment and the size of the construction industry in Iran provide an acceptable sample for developing countries. The annual turnover of the Iranian construction industry was accounted for US$38.4 billion with the estimated growth rate of 4.4% over a four-year period of 2008–2012 (Pournader et

Table 2
Profile of interview participants.

ID	Experience (years)	Role	Organisation	Nature of project
Interviewee 1	24	Academic	University	N/A
Interviewee 2	20	Project manager	Construction contractor	Infrastructure
Interviewee 3	15	Academic	Construction contractor	N/A
Interviewee 4	11	Project manager	Construction contractor	Buildings
Interviewee 5	19	Project manager	Construction contractor	Residential
Interviewee 6	8.5	Project manager	Construction contractor	Residential
Interviewee 7	14	Academic	University	N/A
Interviewee 8	12	Project manager	Consultant	Buildings
Interviewee 9	10.5	Project manager	Client	Infrastructure
Interviewee 10	12	Project manager	Client	Infrastructure
Interviewee 11	11	Project manager	Consultant	Buildings
Interviewee 12	15	Academic	University	N/A
Interviewee 13	22	Academic	University	N/A
Interviewee 14	8	Project manager	Consultant	Infrastructure
Interviewee 15	15	Project manager	Consultant	Residential
Interviewee 16	13 years	Project manager	Construction contractor	Infrastructure

al., 2015). Forecasts indicate 1.4% year-on-year growth in delivery of construction projects for 2015, and an average of 3.1% over the next five years (Dusek, 2016). Besides, Iran's economic future is closely linked to delivery of infrastructure and construction projects (Ghoddousi and Hosseini, 2012) with an unsustainable construction industry being the major issue toward sustainable development in the country (Hakiminejad et al., 2015). As a result, Iranian construction project managers, academic circles and the state are actively engaged in the recognition and investigation of potential measures to make the construction industry sustainable (Hakiminejad et al., 2015). Furthermore, due to the familiarity and experience of the authors within the Iranian construction industry and the ease of access to reliable data, the research team had a prime opportunity to collect information and analyse. As a result, Iran as the context met all the criteria for providing quality data on the topic including accessibility, relevancy of outcome, timeliness and the ease of understanding by the research team. According to the data quality taxonomy proposed by Strong et al. (1997), these point to a case capable of providing quality data for research studies.

The questionnaire used was designed in two parts. The first part included the overarching aims of the research project and the definitions for sustainability alongside a number of questions to cover the demographics. The second part included the CSFs finalised as the outcome of the qualitative stage (see Fig. 2). The respondents were asked to indicate their level of agreement with regard to the level of influence of CSFs on integration of sustainability into project management practices. A five-point Likert-scale was used to elicit the level of agreement where (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).

The list of certified companies was downloaded from the data bank of licensed construction companies. The company names of the list were sorted alphabetically. Afterwards, a random selection was done by using a non-replacement random selection technique as explained by Ghoddousi and Hosseini (2012). Eventually, 421 invitations to participate were sent by email and post to the list of selected companies asking them to distribute the questionnaire among their project managers. Follow up calls resulted in receiving 101 duly completed questionnaires (a response rate of around 24%). The process of preparing the list, data collection and entering data took 4 months and was completed at the end of January 2016.

The conceptual model of the study as illustrated in Fig. 1 suggests a number of associations between concepts included in the model. In such conditions where the hypothesis of the study investigates the associations between variables and the strength of such associations, an appropriate method for data analysis is "multivariate regression" (Ho, 2006). Structural Equation Modelling (SEM) is an effective method for conducting multivariate regression for both confirmatory and exploratory research questions (Ho, 2006). There are two broad methods of conducting SEM being covariance-based (CB-SEM) and partial least squares (PLS-SEM) (Hair et al., 2014). The selection of the most appropriate method is contingent upon the objectives of the study and the nature of the collected data. Given the relatively small sample size, novelty of the conceptual model and capability in analysing models focused on exploration and prediction of associations among a number of constructs, PLS-SEM was deemed the most appropriate as recommended by Hair et al. (2014).

5. Findings of the study

5.1. Customised list of CSFs (interviews)

The interviewees were first provided with two important documents; Agenda 21 for sustainable construction in developing countries (Du Plessis, 2002) and six principles of sustainability (Silvius et al., 2012). The former is the document approved and advised by the United Nations Environmental Program (UNEP) to promote sustainability in developing countries and the latter is the core concept of project management integration with sustainability. These documents were utilised in assisting the interviewees to acquire an accurate understanding of the concepts investigated in this study. This was to make sure all the respondents have a common comprehensive understanding of the topic of the study and their appreciations of the meanings of terms, concepts and requirements are analogous. Interviewees were provided with the list of CSFs (Table 1) and were asked to think loudly about the items. They were asked to express their views about each item in three levels being agree, disagree or detailed modification advice including; add, delete or combine. This process resulted in modifying the list as discussed below.

The factors "transparency in the procurement" and "competitive procurement process" and "multidisciplinary project management team" and "competent project management team" were combined together. The factor of "absence of bureaucracy from the work place" was also omitted since the experts pointed out that removing this factor may be reasonable in the current state of developing countries due to the risk of anarchism and losing any organisational boundaries. Besides, "implementing an effective project monitoring and feedback methodology" was changed to "implementing an effective project monitoring and feedback methodology to evaluate the current state of sustainability and rectify any discrepancy and/or deviation" and "strategic alignment of project goals with stakeholders' needs" was replaced with "strategic alignment of stakeholders' needs with project sustainability goals". In addition, a number of factors such as "comprehensive contractors' portfolio investigation in terms of their level of awareness of the sustainability concept and their previous records of sustainable projects implementation" were added based on the agreement among the interviewees. As the outcome, a list of CSFs comprised of 43 items was finalised as the customised list of CSFs for developing countries (see Table 3).

Afterwards, interviewees were provided with the conceptual model of the study as illustrated in Fig. 1 and were asked to assign each CSF in the final list to different stages of the model. The stage assigned to each CFS was the one on which majority of respondents agreed. The allocation of the CSFs to the stages of the model (see Fig. 1) is illustrated in Table 3.

Table 3
The list of CSFs assigned to consecutive stages according to the conceptual model of the study (see Fig. 1 as well).

No	ID	CSF	Innovation diffusion stage
1	Ide1	A high degree of trust within the project management team (PMT)	Identification
2	Ide2	Commitment to systematic methodologies of project management	Identification
3	Ide3	Enacting required policies in supporting sustainability principles establishment on construction projects by governmental and professional bodies	Identification
4	Ide4	Clearly defined goals and prioritising all stakeholders	Identification
5	Ide5	Well-defined scope of work and project constraints	Identification
6	Ide6	Client's commitment to the needs of other stakeholders	Identification
7	Ide7	Compliance with anti-corruption rules and regulations in the decision-making process	Identification
8	Ide8	Implementing an effective strategic planning regime	Identification
9	Eva1	Effective and open share of knowledge among PMT members	Evaluation
10	Eva2	Knowledge and awareness of sustainable project delivery in the PMT	Evaluation
11	Eva3	Public acceptance towards the project	Evaluation
12	Eva4	Economic and Political stability	Evaluation
13	Eva5	Positive organisational culture in support of sustainable project management	Evaluation
14	Eva6	Strategic alignment of stakeholders' needs with project sustainability goals	Evaluation
15	Eva7	Dominance of constructive relationships among project stakeholders	Evaluation
16	Eva8	Needs assessment of people	Evaluation
17	Eva9	Implementing an effective decision making process by the PMT	Evaluation
18	Com1	Availability of resources (fund, machinery, materials, etc.) as planned throughout the project	Commitment
19	Com2	PMT's adaptability to amendment in project scope and plan	Commitment
20	Com3	Support and cooperation of PMT in delivering a sustainable project	Commitment
21	Com4	Effective allocation of resources by the PMT	Commitment
22	Com5	Strong commitment to sustainable project delivery from project stakeholders	Commitment
23	Com6	Emphasis on high quality workmanship	Commitment
24	Pre_org1	Transparent and competitive procurement process	Preparation-Org
25	Pre_org2	Creating accountabilities, expectations, roles and responsibilities for the organisation	Preparation-Org
26	Pre_org3	Comprehensive contract and specification documentation	Preparation-Org
27	Pre_org4	Effective pre-tendering and tendering investigations	Preparation-Org
28	Pre_org5	Implementing effective health and safety protocols	Preparation-Org
29	Pre_pm1	Project manager's experience and competence	Preparation-PM
30	Pre_pm2	PMT formation based on competency and transparency	Preparation-PM
31	Pre_pm3	Tenure of project managers	Preparation-PM
32	Pre_pm4	Implementing an effective quality control and quality assurance regime by the PMT	Preparation-PM
33	Pre_pm5	Deploying updated and realistic project cost and time estimates by the PMT	Preparation-PM
34	Pre_pm6	Implementing an effective project risk management by the PMT	Preparation-PM
35	Pre_pm7	Implementing an effective change management system during design and construction by the PMT	Preparation-PM
36	Pre_pm8	Implementing effective communication and data exchange protocols at all levels of decision-making within the PMT	Preparation-PM
37	Pre_pm9	Use of lessons learnt in previous projects by the PMT	Preparation-PM
38	Imp1	Comprehensive contractors' portfolio investigation in terms of their level of awareness of the sustainability concept and their previous records of sustainable projects implementation	Implementation
39	Imp2	Use of up to date construction technology and methods for execution of the project	Implementation
40	Imp3	Environmental impacts management by the PMT	Implementation
41	Imp4	Water and noise pollutions minimisation during execution	Implementation
42	Imp5	Effective management of waste during execution phase	Implementation
43	Imp6	Implementing a particular project monitoring and feedback methodology to evaluate the current state of sustainability and rectify any discrepancy and/or deviation	Implementation

5.2. PLS-SEM analysis

As illustrated in Fig. 3, the calculated proportion of respondents in terms of their length of experience was 25.7% with fewer than 5, 29.7% with 5–10, 21.78 with 11–20 and 22.77% with more than 20 years. Hence, around 75% of respondents had more than 5 years of experience in delivering sustainable projects while around 43% had above 11 years of such an experience. The proportion of respondents with regard to the role of their company in the construction industry was as follows. Among the respondents, 56.75% were project managers in contractor companies while 21.21%, 18.18% and 4% were working as project managers for designer, urban housing and companies involved in procurement activities on projects.

Construction companies in Iran are categorised in five classes based on the company size, size of the projects completed and their technical capabilities (Ghoddousi and Hosseini, 2012). According to the common criteria for defining the size, construction companies having below 20 employees are small, companies employing between 20 to 199 employees are classified as medium-sized while companies with more than 200 employees are large-sized (Hosseini et al., 2016). As such, class 1 companies could be regarded as large-sized, classes 2 and 3 are medium-sized and classes 4 and 5 are small companies within the Iranian context (Ghoddousi and

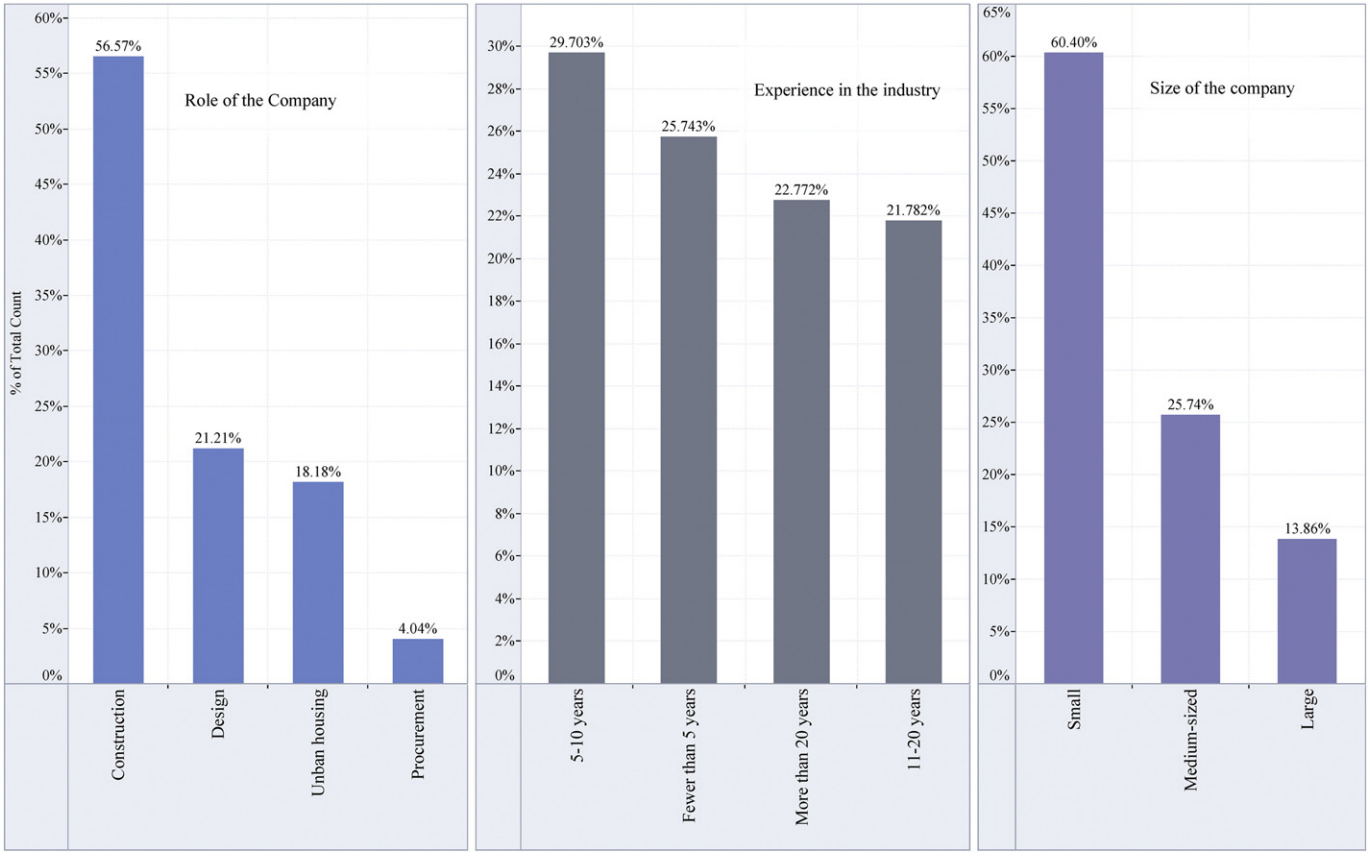

Fig. 3. Profile of respondents (questionnaire survey).

Hosseini, 2012). According to Ghoddousi et al. (2011), around 350 large-sized construction companies are active within the Iranian construction industry. As illustrated in Fig. 3, close to 86% of the respondents were working for small and medium-sized (SMEs) whereas about 14% were working for large-sized companies.

The profile of respondents was regarded as an evidence of their adequate knowledge of strategic and operational features of the Iranian construction industry (in view of the years of experience, variety of roles and sizes of companies included in the sample). Thus, respondents were deemed adequately knowledgeable on the topic of the inquiry.

5.2.1. Measurement models

SmartPLS v.3.2.1 as introduced in length by Hair et al. (2014) was used to run the analysis. Models in SEM are comprised of two main categories of variables being observable or manifest variables (measured through the questionnaire) alongside latent variables showing the underlying constructs associated with manifest variables (Ho, 2006). The associations between manifest variables and the constructs could be specified in formative models where it is assumed that indicators cause the construct, as each one of the indicators captures one of the aspects of the construct. Taken jointly, the indicators determine the meaning of the construct. As a result, breadth and comprehensiveness of the indicators domain is central to ensure that a construct is adequately covered and all aspects are captured (Hair et al., 2014). Therefore, all the identified CSFs (see Table 3) were included as formative items for the constructs based on the outcome of the qualitative stage as illustrated in Fig. 4. The associations between the constructs were defined based on the conceptual model of the study as illustrated in Fig. 1 that provided the origin for specifying the model as illustrated in Fig. 4.

Following the submission of data to SmartPLS, a number of requirements about the data and the specified model should be met in order to ensure that the results of formative models are reliable. The highest priority should be given to the assessment of collinearity which means that two or more formative indicators in a block capture exactly the same information in them. A recommended measure to evaluate collinearity is Variance Inflation Factor (VIF) calculated according to Eq. (1) where x represents variables utilised as formative indicators. For calculating R_x^2, the indicator x is taken and regressed on all the remaining indicators of the same block. R_x^2 is the proportion of variance of x associated with other indicators.

$$VIF_x = \frac{1}{1-R_x^2} \tag{1}$$

In case that the level of collinearity for formative indicators of a construct is very high ($VIF \geq 5$), the variable should be removed from the model prior to conducting any further analysis. The results of the analysis showed that VIF for the

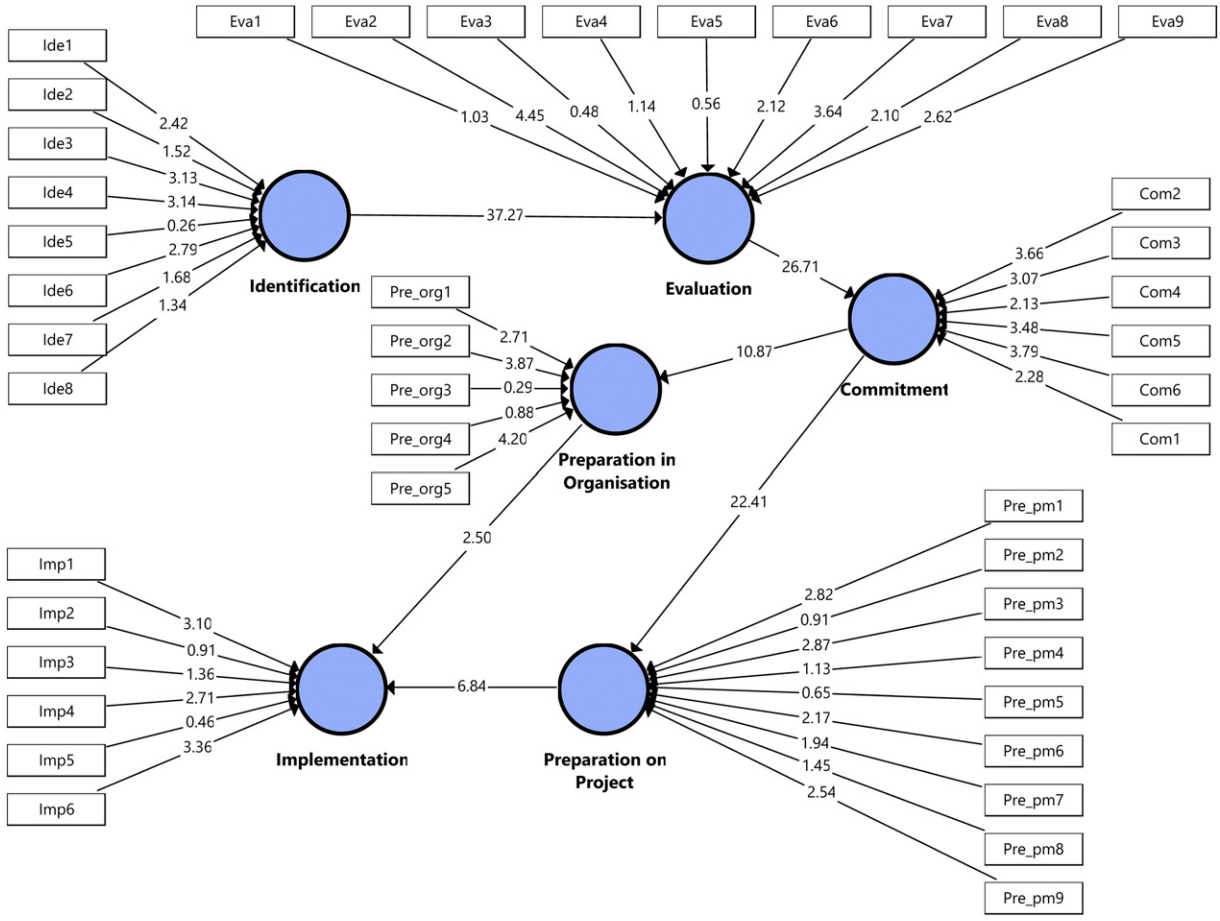

Fig. 4. Initial model (*t*-values for outer weights based on 5000 subsamples bootstrapping).

block of CSFs associated with *commitment* ranges from 1.39 to 1.79. Similarly, the VIF ranges were; for identification (1.27–2.46), for evaluation (1.52–2.73), for preparation constructs (1.57–3.28) and for implementation (1.32–3.00). These were found to be well below the acceptable range ($VIF < 5$) and established that there is no issue with collinearity.

In case, no critical levels of collinearity are observed in the model, SEM-PLS analysis should be performed to analyse the significance of *outer weights* and interpret the formative indicators' relative and absolute contribution to their underlying constructs. Researchers should test if the outer weights calculated in formative models are significantly different from 0 through conducting bootstrapping. To this end, bootstrapping function in SmartPLS was utilised with the algorithm option of *no change sign* and 5000 bootstrap subsamples as a conservative configuration to calculate the significance of outer weights (Hair et al., 2014). The *t*-values were calculated after running the bootstrapping as illustrated in Fig. 4.

The critical value for significance level of 5% ($\propto = 0.05$) is 1.96 (Hair et al., 2014). As shown in Fig. 4, outer weights for a large number of CSFs in the model were well above 1.96 which indicated that these have to be maintained in the model as they were found to be significantly different from 0. Thus, for such CSFs (see Fig. 4), the findings established the significance of outer weights at 0.05($\propto$ level).

Nevertheless, a number of CSFs such as Eva1 showed *t*-values below the cut-off point ($1.03 < 1.96$). For these indicators, the level of outer loadings will define if the indicator is to be removed or retained. That is, any variable with a non-significant outer weight but an outer loading of above 0.5 has to be retained (Hair et al., 2014). This was investigated as illustrated in Appendix B in which the outer loadings and their significance levels were compared against the non-significant outer weights. As presented in Appendix B, all CSFs with non-significant outer weights (highlighted with *t*-values below 1.96) had outer loadings above 0.5, thus were retained in the model.

Based on the results illustrated in Appendix B, the model required no modification and was deemed fit for interpretation of the relative and absolute contribution of each CSF on corresponding constructs of the model. In essence, values of outer weights have to be considered as the relative contribution of the indicators on their construct while the outer loadings show the absolute contribution levels for each indicator in the absence of other indicators (Hair et al., 2014). As a result, CSFs with non-significant outer weights but high outer weights have low relative contribution but acceptable absolute contribution (independent contribution).

Since all the CSFs showed an acceptable level of quality, Fig. 5 was used to discuss the importance of CSFs for the

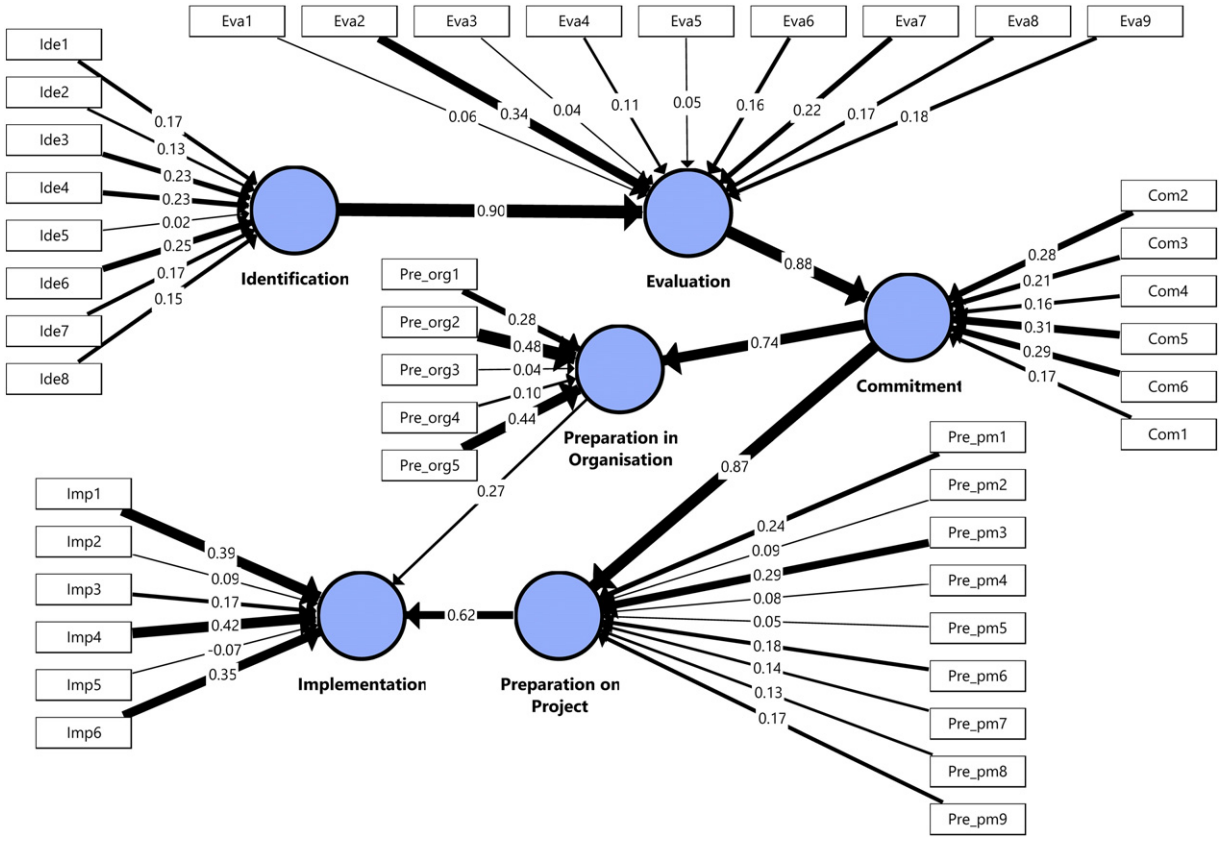

Fig. 5. Final model (relative contribution of CSFs on the constructs alongside path coefficients).

defined constructs in the model. This was to identify which CSFs should be focused on to yield higher levels of sustainability integration into project management practices.

For the identification stage, results as illustrated in Fig. 5 indicate that client's commitment to the needs of other stakeholders (Ide6) stands out as the most important CSF. Enacting required policies in supporting sustainability principles establishment in construction projects by governmental and professional bodies (Ide3) and clearly defined goals and prioritising all stakeholders (Ide4) are the second and third most important CSFs respectively.

As illustrated in Fig. 5, knowledge and awareness of sustainable project delivery in the PMT (Eva2) and constructive relationships among project stakeholders (Eva7) were the two most important CSFs affecting the evaluation stage. Strong commitment to sustainable project delivery from project stakeholders (Com5) was found to be the most influential in the success of commitment stage. Fig. 5 also reveals the importance of high quality workmanship (Com6) to drive the integration of sustainability into project management practices.

The most influential CSFs for preparation in organisation were creating accountabilities, expectations, roles and responsibilities for the organisation (Pre_org2) and implementing effective health and safety protocols (Pre_org5) as illustrated in Fig. 5. As for the construct of preparation on project as illustrated in Fig. 5, the outcome of analysis showed that project manager's tenure, experience and competence as reflected in Pre_pm3 and Pre_pm1 are the CSFs with the greatest effects. The third ranked factor was found to be implementing an effective project risk management by the PMT (Pre_pm6).

As illustrated in Fig. 5, a significant weight is given to the CSF associated with water and noise pollutions minimisation during execution (Imp4). Moreover, contractors' comprehensive portfolio investigation in terms of their level of awareness of the sustainability concept and their previous records of sustainable projects implementation (Imp1) was found to be significantly influential within the implementation stage. Furthermore, implementing a particular project monitoring and feedback methodology to evaluate the current state of sustainability and rectify any discrepancy and/or deviation (Imp6) was among the most effective CSFs as illustrated in Fig. 5 with regard to the implementation stage.

5.3. Structural model

Once it has been confirmed that indicators of constructs are reliable and valid, the next stage involves assessing the predictive capability and associations among the constructs included in the model. Unlike CB-SEM, there is no overall goodness of fit for PLS-SEM (Hair et al., 2014). In essence, the model is assumed to be correct on account of how well the model predicts the endogenous constructs. This is established through assessing the significance of path coefficients, evaluating collinearity issues (among constructs), the values of R^2 and the effect size f^2 for formative models (Hair et al., 2014).

Table 4
f^2 values for the structural model.

	1	2	3	4	5	6
1: Identification		4.199				
2: Evaluation			3.591			
3: Commitment				0.844	3.298	
4: Preparation in organisation						0.096
5: Preparation on project						0.530
6: Implementation						

To test the collinearity, only implementation had two predictor constructs (i.e. 'preparation on project' and 'preparation in organisation'). Utilising Eq. (2) and through calculating the share of construct in terms of $R_{construts}{}^2$, VIF value was below the threshold of 5 as specified in Eq. (2) (both have equal VIF as only two constructs are involved).

$$VIF_{constructs} = \frac{1}{1-R_{contructs}{}^2} = \frac{1}{1-0.655} = 2.89<5 \quad (2)$$

Considering the *t*-values illustrated in Fig. 4 and path coefficients on Fig. 5, it could be inferred that all path coefficients were significant with *t*-values well above the threshold (1.96). Coefficients of determination (R^2) values provide another criterion showing the goodness of the model. As illustrated in Fig. 5, all the constructs had R^2 values close to 0.75. This shows that constructs have been described substantially well in the model. One exception was the construct of 'preparation in organisation' with a R^2 value of 0.458 showing a moderate level of explanatory power for the model. This implied the lower importance of the mentioned construct in the model.

The decision could be made utilising the value of effect size f^2 that indicates if a predictor construct has a substantive impact, as illustrated in Table 4. According to Hair et al. (2014), values around 0.02 show a small effect from the predictor to its corresponding endogenous construct further attesting to the low significance assigned to 'preparation in organisation' as perceived by the project managers in this study.

6. Discussion of the findings

The findings of the study reveal the crucial role of a number of CSFs affecting the integration of sustainability into project management practices alongside the entities responsible for these factors. Table 5 illustrates an overview of the results as discussed below and compared against the findings of previous studies.

6.1. Role of clients in identification

As illustrated in Table 5, the findings of the study highlighted the crucial role of the CSFs associated with role of clients for the identification stage. This is generally in line with observations in previous studies. That is, clients of construction projects as major financial providers play a key role in integration of innovative ideas into existing practices of construction projects (Slaughter, 2000). Nevertheless, the findings of the present study exclusively focus on the central role of clients in the identification stage. Such salience was observed in China with regard to role of clients in identification of practices to make construction projects sustainable (Gan et al., 2015). Incorporating the needs of all stakeholders to make stakeholders happy with the outcome of a project as put by Silvius and Schipper (2016) is also a responsibility for clients. If the clients identify the demand for sustainability to be integrated into project management practices and provide the required supports, alternations on project management practices

Table 5
The most influential CSFs to consider and responsible entities (see Fig. 5 as well).

Stage	CSF	Responsible entity
Identification	Client's commitment to the needs of other stakeholders	• Client
	Enacting required policies in supporting sustainability principles establishment in construction projects by governmental and professional bodies	• The Government • Professional bodies
	Clearly defined goals and prioritising all stakeholders	• Client/PMT
Evaluation	Knowledge and awareness of sustainable project delivery in the PMT	• PMT
	Dominance of constructive relationships among project stakeholders	• Client/PMT
Commitment	Strong commitment to sustainable project delivery from project stakeholders	• Stakeholders
	Emphasis on high quality workmanship	• The Government • Professional bodies • Client/PMT
Preparation in organisation	Creating accountabilities, expectations, roles and responsibilities for the organisation	• Stakeholders
	Implementing effective health and safety protocols	• Client
Preparation on project	Tenure of project managers	• Project managers
	Project manager's experience and competence	• The Government • Professional bodies
Implementation	Comprehensive contractors' portfolio investigation in terms of their level of awareness of the sustainability concept and their previous records of sustainable projects implementation	• Clients • Project managers
	Water and noise pollutions minimisation during execution	• PMT
	Implementing a particular project monitoring and feedback methodology to evaluate the current state of sustainability and rectify any discrepancy and/or deviation	

will occur. However, to succeed in developing countries, this transition requires supportive regulations and financial incentives introduced by authorities (Chang et al., 2016; Hakiminejad et al., 2015). This points to the role of the government and associated professional bodies as illustrated in Table 5.

6.2. Knowledge management in evaluation

Innovative ideas are typically analysed and evaluated with regard to their potential applicability and functionality against key criteria such as cost and long term performance (Slaughter, 2000). Evidence shows that construction companies in developing countries change their unsustainable practices only if there is a proven return on investment (Du Plessis, 2007; Gan et al., 2015). On the contrary, the findings in the present study draw attention to the crucial role of knowledge and sharing of knowledge among team members with regard to sustainability practices within the evaluation stage. That is, the most influential CSFs were closely linked with the knowledge and awareness of the PMT and establishing constructive relationships among stakeholders (see Table 5). This is in line with the statements by Silvius and Schipper (2016) who stressed the role of knowledge and involvement of stakeholders in delivering sustainable projects. The findings could also be justified in view of the severe lack of knowledge on sustainability practices among construction practitioners in developing countries (Gan et al., 2015; Hakiminejad et al., 2015).

6.3. Commitment to high quality workmanship

This finding as illustrated in Table 5 indicated that commitment to high quality workmanship and having stakeholders who support sustainable delivery are central to the success of integrating sustainability into project management practices. The findings corroborated the observation in previous studies on the problems associated with the lack of an experienced and well-trained workforces in the construction industry in developing countries (Tabassi and Bakar, 2009; Tabassi et al., 2012). Nevertheless, the detrimental impacts of such problems were recognised here with regard to impeding the integration of sustainability into project management practices on construction projects (Banihashemi et al., 2014). This is understandable because construction practitioners in developing countries give top priority to time and cost requirements of projects (Martens and Carvalho, 2016) for which they are prepared to sacrifice quality requirements (Ghoddousi et al., 2015). The clear message here is that harnessing the sustainable alternatives of project management practices is to be flowed through a steady stream from committed clients and stakeholders towards high quality skilled workforce on construction projects. Such a workforce should be licensed and trained through enforcing policies by the government that is assisted by professional bodies as illustrated in Table 5. Training will make the workforce innovative and receptive to new ideas (Tabassi et al., 2012) including sustainability. These will not occur in the absence of regulations, clients and a PMT that favour quality concerns over time and cost constraints in delivering construction projects (see Table 5).

6.4. Strategic direction/ health and safety protocols (in organisation)

Focusing on preparation activities in an organisation is perceived as a prerequisite for harnessing innovative practices on construction projects (Murphy, 2014). The findings of the present study however point to the central role of having a strategic direction and incorporating health and safety protocols in an organisation for integration of sustainability into project management practices. This view resonates with the findings by Luu et al. (2008) and Ghoddousi and Hosseini (2012) who stated that fierce competition in the market overshadows strategic planning and health and safety concerns. As a result, concepts including transparency and accountability with regard to sustainability remain literally ignored (Silvius, 2013) where sustainability is all about transparency and accountability as argued by Silvius and Schipper (2016). As illustrated in Table 5, the responsible entities in charge are clients and influential stakeholders who have to ask for transparency, accountability and implementing health and safety protocols in an organisation involved on a project. On the other hand, the organisation should be open to accepting accountability and transparency. In essence, a necessary element for sustainability is “being willing and available to be held accountable for decisions and actions” (Silvius and Schipper, 2016, p. 11).

6.5. Project managers' knowledge, skills and abilities (KSAs)

The most influential CSFs for preparation on projects were found to be the tenure of project managers as well as their experience and competence as illustrated in Table 5. This could be translated to the crucial role of project managers KSAs in line with previous studies (Martens and Carvalho, 2017). Even more, sustainability has been mentioned by well-known project management standards such a Project Management Institute as an area of professional responsibility for project managers (Silvius and Schipper, 2016). This finding brings to light a major barrier to integration of sustainability into project management practices in the construction industry in developing counties. That is, evidence shows that many project managers in such countries do not possess the required KSAs enabling them to utilise resources efficiently (Ghoddousi and Hosseini, 2012). Besides, less developed countries only focus on technical KSAs for recruiting project managers and ignore soft skills such as those associated with sustainability (Ahsan et al., 2013). For developing countries, this makes the transition to sustainability challenging and calls for enforcing policies by the government for recruiting licensed project managers at least on publicly-funded projects. Professional bodies also have to address this barrier by providing necessary training and skill development programs as illustrated in Table 5.

6.6. Tighter control over construction activities

Constructing activities are notorious for being among of the primary sources of waste generation, material depletion, noise, water and environmental pollutions in developing countries (Chang et al., 2016; Hakiminejad et al., 2015). The findings emphasised the crucial role of water and noise pollution (Table 5), yet waste management was found to be of lesser influence. This was in sharp contrast to the arguments proposed by previous studies (Hwang and Tan, 2012; Marcelino-Sádaba et al., 2015) that give a top priority to waste management when it comes to sustainability on construction projects. As a novel insight, the findings point to a strategic plan to make construction activities sustainable. Operational features such as waste management become the by-products expected of such a strategic plan. Of particular interest should be imposing a tighter control on operational activities on projects to reduce risks (Silvius and Schipper, 2016). This includes focusing on the selection process of contractors to identify companies which are familiar and capable of sustainable operations (Table 5). Enforcing tighter controlling regimes to ensure that activities are performed in conformance to sustainability requirements (TBL).

7. Conclusion

As one of the first studies in its kind, the present study contributes to sustainability in project management area in several ways. First, the study proposes a pool of CSFs for integration of sustainability into project management practices on construction projects that is customised for the context of developing countries. Second, the stages of integration of sustainability into project management practices are conceptualised by encapsulating these CSFs in a conceptual model. This conceptual model is validated in exposure to data collected from a developing country. As such, the study presents the first quantification of the strength of CSFs for integration of sustainability into project management practices for each stage in the form of a model. Findings reveal novel insights related to the integration of sustainability into project management practices for developing countries. These views uncover the most important areas to be considered for each stage of the integration and identify the most influential key players manipulating this course of integration. For practice, the findings of the study provide guidelines for policy makers and companies' directors in developing countries. That is, the findings enable them of identifying the most crucial areas for focusing their efforts and allocating resources efficiently in view of the outcomes of this study.

Nevertheless, the study findings should be considered with caution due to a number of limitations. That is, the findings have to be applied to other developing countries in light of the socio-economic discrepancies between Iran and other developing countries. Moreover, the sample size was relatively small and the respondents mostly came from contractor companies and SMEs. As such, the findings might not reflect the perceptions of project managers in large-sized companies, clients and designers. Furthermore, CSFs were explored merely from the perspective of project managers, thus might be biased toward the role of project managers. These limitations warrant further investigation by validating the model in other contexts and using larger samples that cover different sizes and various types of companies. Exploring the CSFs incorporating the viewpoints of a wider range of project stakeholders might add value to the findings presented here as another fertile ground for future research studies.

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ijproman.2017.01.014.

Conflict of interest

The authors of this article certify that they have no affiliations with or involvement in any organisation or entity with any financial or non-financial interest in the subject matter or materials discussed in this manuscript.

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