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Project success and critical success factors of construction projects: project practitioners' perspectives

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Abstract: Project management is primarily practitioner-oriented and loaded with many critical success factors (CSFs), and although these are well-evidenced in theory, they do not deliver as efficiently as factors of interest to project professionals during execution. The present study explores the perceptions of senior project managers (PMs) about project success, CSFs and complexity in large construction projects. Data from project practitioners were collected through semi-structured interviews and analysed using content analysis. The participants were selected with convenience sampling method given the complex understanding of the domain and included highly experienced PMs from the global community with expertise in project management. PMs perceive a small number of CSFs in contrast to the large exhaustive CSFs listed in the questionnaire surveys. Though important, traditional constraints of the Iron Triangle are considered inadequate in defining project success. Project professionals are seen as relying more on other performance indicators for defining a project as a success. They perceive complex construction projects in terms of a large number of interfaces, complex working systems and uncertainty. The findings of this paper suggest that project practitioners perceive differently about the CSFs and project success.

Keywords: critical success factors, content analysis, complexity, Iron Triangle, construction projects, project success, questionnaire surveys

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1 Introduction

The construction industry plays an important role in the economy, contributing significantly to the national GDP, capital formation and employment (Cheng et al. 2021) and directly or indirectly influencing other sectors (Tripathi and Jha 2018), but it is continuously facing problems pertaining to resource planning, risk management and logistics, resulting in schedule delays, design defects, cost overruns and disagreements (Akinosho et al. 2020) amidst serious performance shortfalls and technological and budgetary uncertainties, with projects becoming increasingly complex and difficult (Siraj and Fayek 2019). The multifaceted, volatile and dynamic nature of construction poses problems in modelling the construction process (Hajdasz 2015). The construction industry is widely denounced for its low results. The key aim of a construction project is to succeed and the major challenges include global market settings, limited resources, limited budget, shortage of qualified and experienced workers, and intense competition (Ingle and Mahesh 2020). Performances characterised by poor compliance in terms of adherence to the budgeted cost and schedule have been characteristics of construction projects; and delays in execution are observed to be very expensive, adversely affecting project cost and profit margin (Hasan and Jha 2019). Zhu and Mostafavi (2017) cited a study by Construction Industry Institute (2012) observing that out of the 975 construction projects analysed, only 5.4% met their planned cost and schedule performance objectives. Project Management Institute reported that US$ 97 million are lost for every US$ one billion invested in projects that failed to achieve their objectives (PMI cited in Martens et al. 2018). With regard to the Indian context, the Govt. of India report (July 2022) on central sector infrastructure projects costing US$ 20 million (INR 150 crore) and above reported that out of 1505 monitored projects, 661 projects (43.92%) were delayed, 386 projects (25.65%) reported cost

overrun and 222 projects (14.75%) reported both cost and time overruns vis-à-vis their original project implementation schedules (Infrastructure and Project Monitoring Division 2022).

'*A construction project is considered as successful when it is completed in time, without cost overruns, and within the specified quality parameters*' (Sinesilassie et al. 2019). Success factors are interconnected performance factors contributing to project success (Olugboyega et al. 2020), forming the basis for organisations to achieve success on a project (Nguyen et al. 2020). The essence of project success is that the right projects are done right (Langston et al. 2018). Other metrics of success include functionality, contractor's competitiveness, absence of lawsuits and legal cases, and occupiers' 'fitness for purpose' (Duy Nguyen et al. 2004). Project success is among the most studied themes in project management due to its complexity in defining success and the factors contributing to its achievement. Despite this, the term project success still remains diffuse and its meaning is often subject to the vagaries of the interpretation preferred by the eye of the beholder (Jugdev and Müller 2005).

The critical success factors (CSFs) of a project are project management system inputs that directly raise the chances of attaining success on a project (Gudienė et al. 2014 cited in Maghsoodi and Khalilzadeh 2017). Over the past decade, several works have recognised the factors that support the successful completion of construction projects, especially the factors that have a greater effect on project success than others (Altarawneh and Samadi 2019). There are very few studies considering practitioners' viewpoints and providing valuable insights to project professionals in their daily activities (Townsend and Gershon 2020). The majority of the previous work in the CSF area under project management literature relied on questionnaire surveys and has identified long lists of factors. While these factors identify areas requiring critical attention, they still do not create a good fit with the most-cited definition of CSFs by Rockart (1982, p. 4) as '*those few key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his or her goals*'.

To observe the CSFs, both qualitative and quantitative methods are applied. Ahmed et al. (2021) observed that the survey questionnaire method for measurement of project success is among the most commonly used methods, a standard method in project management literature, and a well-accepted way of measuring this outcome. They synthesised 60 research studies in a systematic literature review of project managers (PMs)' leadership competencies in achieving project success and found that 43 studies used the survey questionnaire method. Among these 43 studies, 35 used a 5-point Likert scale and 5 used a 7-point Likert scale. Quantitative method usage is high; however, the outcomes observe gaps in different contexts. This paper applies a qualitative method to ensure that the project wholly inherits the trait of comprehensiveness, which would not be possible to capture by the use of quantitative methods.

The authors explored the perceptions of project practitioners on three themes, that is to say project success, CSFs, and artificial intelligence applications in handling construction projects. The new dimension of artificial intelligence is observed to be considered a successful application and the results of the study on same have been published in Kumar et al. (2021). This study presents the results of the themes 'project success' and 'critical success factors'. Tabish and Jha (2012, p. 1131), citing Whitehead (1998), observe that statisticians suggest to limit the variables that are irrelevant as they result in poor model fit. A review of the literature revealed long lists of CSFs identified in previous studies based on the questionnaire surveys; however, this is in contrast to what has been debated about CSFs in the literature. Based on the research gaps identified, this paper addresses the following questions: (i) Do project practitioners perceive a large number of CSFs during the construction works? (ii) Do project practitioners consider traditional constraints of the Iron Triangle as adequate in defining project success? (iii) How do project practitioners perceive complex construction projects as successful projects? The research outcomes address the existing gaps and improve the understanding of project success, CSFs, complexity and complex construction projects.

The rest of the paper is structured as follows. Section 2 provides the literature review; Section 3 presents the research approach; Section 4 presents the results and discussion; and Section 5 presents the conclusions. Finally, Section 6 discusses the limitations of this research as well as directions for future research.

2 Literature review

In the project management approach, CSFs and project success research are frequently considered among the key ways of enhancing project delivery effectiveness (Chan et al. 2004). Over time, researchers have proposed various frameworks for the classification of project success into different categories. McLeod et al. (2012) classified project success into three categories, that is to say process success, product success and organisation success, whereas Zwikael and

Smyrk (2012) classified project performance into 'project investment success', 'project ownership success' and 'project management success'. Joslin and Müller (2015) included project efficiency, project impact, organisational benefits, stakeholder satisfaction and future potential among additional project success criteria besides the three traditional criteria of the Iron Triangle. Al-Tmeemy et al. (2011) divided project success into the three categories of product success, project management success and market success. Shenhar and Dvir (2007) considered project success as a dynamic concept having short-term and long-term implications. They suggested five basic groups of measures (impact on customer, efficiency, preparation for future, business and direct success, and impact on teams) for a comprehensive assessment of project success in the short and long terms. De Wit (1988) and Baccarini (1999) differentiated between project management success and product success. Product success (measuring against the project's overall objectives) is different from project management success (measuring performance on time/cost/quality/performance specifications). Joslin and Müller (2015) opined that project management success is a short-term measure and relates to efficiency, and project success is a long-term measure and relates to effectiveness and impact.

Amidst various frames of understanding, Radujkovic and Sjekavica (2017) opined that making a strong differentiation between project management success and project success is hard on account of their mutual relationships. Misic and Radujkovic (2015) opined that '*understanding of megaproject performance goes beyond Iron Triangle, and includes wider participants*'. The debate on the project success definition is still continuing, with various authors believing that a common consensus has not been established on the measures of project success in the construction industry (Akbari et al. 2020; Luo et al. 2020). Previous research has disagreed on the project success definition and the best way to achieve it (Townsend and Gershon 2020). Research into project success is more dominant than ever, which shows the growing recognisation of the importance of improving project delivery; however, the question of the optimal means for the achievement of project success is one that still needs to be solved, which is evidenced by the recurrent failures of all kinds of projects (McDermot et al. 2020).

CSFs are the factors that constitute, influence and determine project success and are the most notable concepts of construction project success (Soon Han et al. 2012). Daniel was the first to discuss the concept of success factors in the 1960s (Leidecker and Bruno 1984). Rockart, based on Daniel's concept, introduced the CSFs approach and defined CSFs as '*those few key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his or her goals*' (Rockart 1982). A seminal study on CSFs is the study of Pinto and Slevin (1987), who are recognised as having devised the standard and most widely utilised theoretical framework to assess project success (Jugdev and Müller 2005; Davis 2014). Pinto and Slevin (1987) defined CSFs as '*those factors which, if addressed, will significantly improve project implementation chances*' (Pinto and Slevin 1987, p. 22). However, Pinto and Slevin (1987) developed this CSF model based on only 52 usable responses, and responses were limited to only one stakeholder group (project team). Pinto and Slevin (1989) opined that CSFs, though predictive of project success, come into play at different stages of a project's life cycle (Pinto and Slevin 1989). Wang et al. (2022) performed a literature review of studies on the CSFs and success criteria for mega infrastructure construction projects for the period between 2000 and 2018. They found partnering/relationships with key stakeholders; adequate resource availability; adequate communication and coordination among related parties; clear strategic vision; and public support or acceptance as the top five CSFs. Many authors have recognised the significance of understanding the influence of CSFs on project performance for improving project efficiencies and effectiveness (Sinesilassie et al. 2019). The success factors are vast and diverse; so, identifying and focussing on CSFs among them might improve the project's efficiency and contribute to the project's success (Maghsoodi and Khalilzadeh 2017). It is difficult to prioritise, categorise and reduce the CSFs to a more manageable number and therefore a compelling model encompassing all CSFs has yet to be developed and indeed may be impossible (Langston et al. 2018).

Over the period, project management researches have defined CSFs for different project types, project sizes, procurement methods, countries and stakeholders, as well as for different success categories (project success, product success, project management success, etc.). Although numerous CSFs are observed being cited in scientific literature, a few show statistical significance in describing each of the success dimensions, and many CSFs, although well-evidenced in theory, do not deliver as a factor of interest to project professionals during execution (Pacagnella et al. 2019). Varied lists of CSFs for construction project success have been documented by different researches. Kumar et al. (2021) documented a comprehensive list of CSFs identified in previous research (Table A1 in Appendix).

Diverse sets of CSFs for project success on construction projects documented by several previous studies are either too generic, posing problems when implemented in

practice (Duy Nguyen et al. 2004), or specifically limited to a particular project (Belassi and Tukel 1996). The project failures are still very high, and a possible reason could be these CSFs not including sufficient know-how, to help support decision making by project professionals (Zwikael and Globerson 2006). Moradi et al. (2020), in a longitudinal study, identified 338 success factors, documented 132 success factors after synthesising and excluding similarities and observed 65 factors as weighty success factors contributing to project success.

Pollack et al. (2018) performed a scientometric analysis of project management research for the period 1970–2015 to explore the concepts central to the Iron Triangle. They found that the Iron Triangle concept can effectively communicate interrelations among central success criteria. However, researchers are increasingly pointing to the inadequacy of the Iron Triangle to wholly measure project success and suggesting other key performance indicators such as stakeholder satisfaction, safety, sustainability, compliance with audit and transparency, etc. (Tabish and Jha 2018).

Understanding complexity is very important and significant for PMs on account of differences associated with decision making and achievement of goals that are related to complex projects, influencing the CSFs and affecting the project management. There is disagreement on the definition of complexity (Cristobal 2017). The efforts to define complexity often refer back to systems theory (Davies and Mackenzie 2014). Baccarini (1996) defined project complexity as '*consisting of many varied interrelated parts and can be operationalized in terms of differentiation and interdependency*'. Many authors considered Baccarini's (1996) work as a starting point in project complexity research (Mikkelsen 2021). De Rezende et al. (2018) performed a bibliometric network analysis of 50 years of project complexity research to present a broader and clearer image of the field. They found that the project complexity is defined by novelty, structural, pace, uncertainty, social–political, regulative and dynamics dimensions. They further found that now the focus is changing from project control to project adaptability and it necessitates developing capabilities for managing complex projects. Burke and Morley (2006) defined complexity as the '*number and heterogeneity of different elements that interrelate*'. They opined that complexity is an inherent and defining feature of projects and its effect on project performance is still not completely discovered (Burke and Morley 2016, p. 1243 cited in Bjorvatn and Wald 2018). The definition of complexity as '*consists of many different elements with multiple interactions and feedback loops between elements*' provided by Hatch and Cunliffe (2012) is observed to be among most cited in the research literature (Hatch and Cunliffe 2012, p. 1204 cited in Bakhshi et al. 2016).

3 Research methodology

This study applies a qualitative content analysis. This methodology is frequently adopted to comprehend a phenomenon requiring deeper understanding. The methodological framework used for qualitative content analysis is broadly based on the recommendations of Kuckartz (2019) and Erlingsson and Brysiewicz (2017). A qualitative approach is '*appropriate to use to study a research problem when the problem needs to be explored; when a complex, detailed understanding is needed*' (Creswell 2013). It is used for exploring new phenomena and for capturing individuals' understandings of meaning and processes (Given 2008). Qualitative research is characterised by generating understanding rather than testing (Corbin and Strauss 2008); it '*emphasizes words rather than quantification in the collection and analysis of data*' (Bryman 2012). Interviews, as a qualitative approach instrument, can be used to investigate novel occurrences and record individual perceptions of meanings and processes (Given 2008).

3.1 Interviews

Interviews are seen as a research strategy/technique for theory generation/theoretical framework generation and qualitative interviews have the potential to generate insights and concepts and expand our understanding (Knight and Ruddock 2008). Semi-structured interviews are employed to '*learn the respondent's viewpoint regarding situations relevant to the broader research problem*' (Blumberg et al. 2008, p. 386 cited in Davis 2017), provide rich data collection and allow for clarifications and extension of questions and answers during the interview (Davis 2017). We chose semi-structured interviews to allow for the identification of additional themes during discussions and the opportunity for elaboration by the interviewees. Different authors have recommended a different number of interviews to arrive at saturation in qualitative studies. Creswell (1998) recommended between five and twenty-five interviews while Kuzel (1992, p. 41) recommended six to eight interviews (Creswell 1998, p. 61; Kuzel 1992, p. 61 cited in Guest et al. 2006). Galvin (2015) found 8–17 interviews as the most common range and Hennink et al. (2017) observed that code saturation was reached at 9 interviews.

The interviewees were selected on a convenience basis and included highly experienced project practitioners

from the global community with expertise in project management, working on large construction projects and engaged in high-end technology. We conducted a total of nine face-to-face interviews between March 2019 and June 2019. Eight of the interviews took place in France and were video recorded while one interview took place in India and was audio recorded. All nine interviews were then manually transcribed verbatim. Data were coded manually and analysed using content analysis.

3.2 Data analysis related issues

Davis (2017) observed that in qualitative studies, validity and reliability terms, which are viewed as quantitative measures, seemed inappropriate and these need to be replaced with 'truth value' and 'consistency/confirmability'. To ensure credibility, due care was taken during the research. Interview questions were developed based on the main theme and sub-themes identified during the literature review. These were also discussed with and reviewed by two academic and two industry experts and were refined as per their suggestions. An interview protocol was developed and finalised in consultation with the two academic experts. The questions were pilot tested with one project professional in the presence of an academic expert to check for clarity of terms.

3.3 Interview organisations

The professionals we interviewed represented seven geographic regions and were handling projects in eight different sectors. Table 1 summarises the interviewees' profiles, including geography and projects handled.

4 Results and discussion

The perceptions of senior PMs on project success, CSFs and complexity were varied and mixed. Their response to the number of CSFs was in contrast to the long lists of CSFs identified in the published literature. The results are discussed in detail below.

4.1 Respondents' profile

All respondents except one had professional engineering qualifications and were working as PMs or PDs handling large construction projects with varied teams. Their experience ranged from 10 years to 33 years; specifically in project management, the average was 17.9 years. The construction cost of projects ranged from € 60 million to € 35 billion.

4.2 Themes and sub-themes identified

The interviews were manually coded, highlighting the trends and differences in the respective interviewee's responses. After the initial coding, similar codes were collated and analysed and themes were developed. These themes were then analysed to reveal the perceptions of the respondents about CSFs, project success, and complexity. Table 2 shows the two main themes and related sub-themes identified during the process.

4.3 CSFs

Various CSFs perceived by the respondents are detailed in Table 3 below. Broadly, 20 different CSFs were perceived by the respondents, with 'planning' being the most common (six respondents), while 'good/partner relationship with the client' (four respondents) occupied the second place and 'skilled resources/resources' (three respondents) occupied the third place.

Construction projects are becoming increasingly complex and achieving success on these large-scale complex projects is becoming increasingly problematic for the project teams. Previous research has observed that project success is rarely assessed across multiple stakeholder groups because the focus is usually on the PM's perception (Davis 2014, 2018). We understand that a high percentage of failed construction projects, despite vast research in the CSF area, is on the account of different interpretations of project success and CSFs. The possible reason for this, we understand, is considering limited aspects of construction projects during the research, that is, considering only one project type, one project procurement method, or limited CSF attributes, or performing the research with limited stakeholders. Some recent studies documenting a large number of SFs are listed in Table 4. In contrast, on being requested to name the top five CSFs, six of the respondents struggled to reach up to the fifth factor (Table 5). Previous research in the CSFs area has reported a low response rate in questionnaire surveys due to the lack of participation from the construction industry (Yong and Mustaffa 2013). The reasons cited for this include work commitments, lethargy towards research (Dulaimi et al. 2003; Abdul-Aziz et al. 2012) and industry fatigue towards numerous requests to complete questionnaire surveys

Tab. 1: Respondents' profiles, including geography and projects handled.

S. No.	Item	Respondent 1 (PD)	Respondent 2 (PM)	Respondent 3 (PD)
1	**Qualification**	Masters in science	Degree in engineering	Masters in geology
2	**Total experience (years)**	15	15	33
3	**Present project**			
3.1	Project type	Airport	Nuclear	Road, building
3.2	Project location	Saudi Arabia	France	Algeria
3.3	Role in project	PD	PM	PD
3.4	Project cost (tentative)	Project 1 – US$ 9 billion (construction cost) Project 2 – US$ 100–200 million (construction cost)	€ 35 billion (construction cost)	Project 1 – € 110 million (consulting fee) Project 2 – € 40 million (consulting fee) Project 3 – € 8 million (consulting fee)
3.5	Present progress	Construction stage	Construction stage	Project 1 – closure stage Project 2 – ongoing Project 3 – closure stage
S. No.	**Item**	**Respondent 4 (PD)**	**Respondent 5 (PM)**	**Respondent 6 (OM)**
1	**Qualification**	Graduate engineer, MBA	Masters in engineering	High school
2	**Total experience (years)**	23	11	15
3	**Present project**			
3.1	Project type	Mining	Light rail	Road (O&M)
3.2	Project location	Africa	France	UK
3.3	Role in project	PD	PM	O&M manager
3.4	Project cost (tentative)	€ 2 billion (construction cost)	€ 80 million (construction cost)	£ 300 million consulting fee for a 30 year O&M contract
3.5	Present progress	Recently completed	Construction stage	O&M
S. No.	**Item**	**Respondent 7 (DPD)**	**Respondent 8 (PM)**	**Respondent 9 (PM)**
1	**Qualification**	Masters in research, master's in engineering	Engineering, business administration	Graduate engineer
2	**Total experience (years)**	15	14	25
3	**Present project**			
3.1	Project Type	Road	Green Network	Road
3.2	Project location	French island	France	India
3.3	Role in project	DPD	PM	PM
3.4	Project cost (tentative)	€ 5 billion – construction cost	€ 60 million – construction cost	≥₹ 5 billion – construction cost
3.5	Present progress	Construction stage	Construction stage	Recently completed

PD, project director; DPD, deputy project director; PM, project manager; OM, operations and maintenance manager; O&M, operations and maintenance.

on a regular basis (Yong and Mustaffa 2013). Dulaimi et al. (2003) opined that a low response rate can affect the results due to the sample bias effect; and limitations pertaining to the use of perception rating using a Likert scale might result in various information errors. The respondents' answers having indicated such a large number of CSFs may, according to our understanding, be attributable to the fact that large lists of CSFs were presented as part of the survey questionnaires provided to them (in concomitance with the requirement of returning the completed surveys). It represents the existence of a research gap in the identification of the CSFs through the questionnaire survey, wherein an exhaustive list of CSFs is presented to the respondents to choose/rank vis-à-vis the actual and few CSFs as perceived by the project professionals.

The 10 factors listed in Pinto and Slevin's (1987) 'diagnostic behavioral instrument' are project mission, top management support, project schedule/plans, client consultation, personnel recruitment, selection and training, technical tasks, client acceptance, monitoring and

feedback, communication and troubleshooting. However, the CSFs perceived by the project practitioners are significantly different from the list of these 10 CSFs proposed by Pinto and Slevin (1987). This suggests a research gap that would necessitate finding an updated list of CSFs apart from testing the current CSFs lists through questionnaire surveys in different contexts and performing the research considering limited aspects of construction projects.

4.4 Project success

The respondents' opinions on what makes a project successful were varied to a great extent (Table 6). Three respondents attributed the project's success to the identification and retention of proper resources. One respondent attributed the project's success solely to the people working in a good environment. One respondent attributed the project's success to understanding the prevalent cultural differences so that one can communicate properly to make the project successful. One respondent believed that the PM's personality and relationship intelligence, as well as his way of organisation and handling of resources, makes a project successful. One respondent opined about the necessity for having a shared vision with the client, a good level of communication with all stakeholders, good organisation and the ability to manage human resources and technical issues.

One respondent opined that good management of stakeholders (both internal and external) would make a project successful. One respondent opined that client satisfaction and good revenue from the project would make a project successful, stressing that client satisfaction would help in winning other projects in the future. Getting repeat orders from the client was considered proof of project success (in the previous project) by one respondent. Thus, the majority of items described as necessary for project success pertain to soft skills, thereby clearly indicating a shift beyond the Iron Triangle to rely more on other dimensions for defining a project as a success.

Tab. 2: Theme and sub-themes.

Theme	Sub-themes
Theme 1 CSFs	(1a) Top five CSFs
Theme 2 Project success	(2a) Define project success.
	(2b) What makes a project successful?
	(2c) Project success and Iron Triangle
	(2d) Complexity/complex construction project

CSFs, critical success factors.

Tab. 3: Top five CSFs – interviewee results.

Respondent	CSF1	CSF2	CSF3	CSF4	CSF5
Respondent 1	Planning	Skilled resources	Procurement strategy	Good communication	Cost-control and contract
Respondent 2	Human factor/common goal	Planning	Convincing stakeholders	Access to IT technology	Flexibility in contract
Respondent 3	Good proposal	Good organisation	PM	Team composition	Partner relationship with the client
Respondent 4	Capacity/infrastructure	Time schedule (planning)	Budget	Functionality	Environmental issues
Respondent 5	Common objective	Efficiency in taking decisions	Good relationships within and outside team	Stakeholder involvement	-
Respondent 6	Planning	Project team	Project equipment	Software	Communication
Respondent 7	Cost (budget)	Planning	Resources	Good relations with client	Good relations with contractors
Respondent 8	Client satisfaction	Partner relationship with client	Technical expertise	Project margins	Team competence and pleasure
Respondent 9	Identification of right resources (manpower)	Planning	Good relations with client	Good relations with contractors	Timely and contractual resolution of issues

CSFs, critical success factors.

Tab. 4: Recent studies documenting a large number of success factors (SFs).

S. No.	Paper	Journal	Author name	Year	Total No. of SFs listed
1	Can artificial intelligence be a critical success factor of construction projects?: Project practitioners' perspectives	Technology Innovation Management Review	Kumar et al.	2021	64
2	The competence of project team members and success factors with open innovation	Journal of Open Innovation: Technology, Market, and Complexity	Oh and Choi	2020	31
3	Factors influencing the performance of architects in construction projects	Construction and Economics Building	Marisa and Yusof	2020	23
4	Critical success factors for sustainable construction project management	Sustainability	Gunduz and Almuajebh	2020	40
5	Critical success factors for large building construction projects – perception of consultants and contractors	Built Environment Project and Asset Management	Mathar et al.	2020	91
6	PLS-SEM approach for predicting the success of public–private partnerships in construction projects: Indian context	Iranian Journal of Science and Technology, Transactions of Civil Engineering	Chidambaram and Tamilmaran	2020	57
7	The relationship between critical success factors and success criteria in construction projects in the United Arab Emirates	International Journal of Advanced and Applied Sciences	Altarawneh and Samadi	2019	33
8	Critical success factors for project manufacturing environments	Project Management Journal	Pacagnella et al.	2019	38
9	Critical success factors for different components of construction projects	Journal of Construction Engineering and Management	Kog and Loh	2012	67

Tab. 5: Top five CSFs for construction project success – respondents' reactions.

S. No.	Respondent	Example quotes
1	Respondent 1	*'Fifth one … uh … you can say …'*
2	Respondent 2	*'Fifth one … a … what can I say …'*
3	Respondent 5	*'I don't have any idea for the fifth one. But if I have one, if it comes in the interview later, I will tell you'*
4	Respondent 6	*'Fifth one is … I can't think of anymore.'*
5	Respondent 7	*'… and in five what I would say is, during execution phase, I think we have to get very good relationships with the contractors.'*
6	Respondent 8	*'And, I guess, …'*

CSFs, critical success factors.

Seven respondents were of the view that though time, cost and quality are required to define a project's success, yet these cannot completely define the project success and additional indicators are needed for defining the project's success completely. They opined environmental issues, client relationship/satisfaction, stakeholder management, the 10 knowledge areas/focus areas, leadership and risk as being the required additional dimensions. The other two respondents considered the Iron Triangle sufficient to define project success, with one respondent considering the Iron Triangle as still being the core of project success and another considering the Iron Triangle as being sufficient for defining project success in simple projects.

The perceptions of project practitioners on project success are in line with the previous research on project success, which has found that the project success definition has considerably evolved over the last few decades. During the 1970s it focussed only on the application of project management tools and nowadays is concerned with the satisfaction of project stakeholders' requirements (Davis 2014). Further, ever-increasing environmental consciousness and ever-changing customer demands are making the achievement of project success increasingly

tough (Albert et al. 2017). This study's results on the inadequacy of the Iron Triangle to completely define project success are in line with the finding of recent studies necessitating consideration of additional project success metrics such as stakeholder satisfaction, safety, sustainability, compliance with audit and transparency (Tabish and Jha 2018), efficient use of resources, effectiveness and reduced conflicts (Toor and Ogunlana 2010) to completely measure project success.

4.5 Complexity

Different respondents perceived project complexity in different ways (Table 6). One respondent perceived complexity as involving all elements of the urban development project, and the complex project as one having all systems and all different interactions on the project. One respondent perceived a complex project as the one having a huge system with many, many stakeholders, complex working systems, complex communication and complex IT systems requiring a systematic approach to define these systems properly, as well as an understanding of the links between different offices and the processes required to be put in place for working with multiple organisations. One respondent perceived complexity in terms of interfaces, with more interfaces meaning higher complexity, and opined that cost, size, geographic area or culture are not indicators of complexity. One respondent viewed complexity as being linked to technique, technical aspects and uncertainty. One respondent viewed complexity in terms of having a more complex organisation or managing more complex tools and linked complex projects to the number of stakeholders. One respondent linked a complex project with the number of stakeholders and expressed an understanding of a complex project as one characterised by being constituted with many different elements that do not all work together, with the result that one has to try to make them fit together to obtain end results.

Thus, six respondents associated complexity/complex projects with a large number of interfaces/stakeholders, in line with the findings of Ceric et al. (2021), who associated megaprojects with a 'multitude of stakeholders' and 'complexity in interrelationships'. Two respondents associated complex projects with complex working systems/tools, complex communication and complex IT systems requiring a systematic approach, and one respondent associated complexity with uncertainty.

In the present study's respondents' responses, we observed that there was a lack of consensus about the parameters by the aid of which a project might be defined as being a complex project, as well as by which it might be characterised as having a high level of uncertainty, a high number of elements and other critical aspects concerned with project complexity; and this finding implies the existence of commonalities between the findings of this study concerning complexity and those of the reviewed literature. Respondents' perceptions of complexity/complex construction projects were broadly in line with the findings of Hatch and Cunliffe (2012) and De Rezende et al. (2018). Shenhar and Dvir (2007) opined that most projects fail mainly because conventional project management concepts cannot adapt to a dynamic business environment. They proposed a new approach, based on four critical dimensions of novelty, complexity, pace and technology, that are relevant to projects but challenging to manage. They opined that most of the project problems on projects are managerial and not technical – thereby indicating the importance of understanding project success (and CSFs) from the viewpoint of project practitioners. Similarly, Wagner and Radujkovic (2022) emphasised the necessity for a collaborative approach during the planning and execution of projects for bringing the public sector's level of projectification closer to those of private businesses.

5 Conclusions

Although project success is a comprehensive topic and among the most studied themes in project management, a common consensus has not been established on the measures of project success in the construction industry. CSFs in previous studies have been mostly identified through cross-sectional questionnaire surveys primarily relying on self-reporting by respondents. Various studies have identified this self-reporting among sources of biasedness as respondents may choose to share success stories only. Further, previous research on CSFs has been carried out considering limited aspects of construction projects, and such a practice has resulted in long and diverse lists of CSFs with each list applicable in a limited context/condition. Therefore, a common understanding of project success and a CSF model globally applicable to all types of projects is yet to be developed.

This study explored the perceptions of project practitioners about project success, CSFs and complexity to address the following three questions – (i) Do project practitioners perceive a large number of CSFs during the construction works as presented in questionnaire surveys? (ii) Do project practitioners consider traditional

Tab. 6: Project success – interviewee results.

Sub-theme	PD	DPD	PM	OM	Sub-sub-theme	Example quotes
Define project success	3	1	4	1		*'Project success is when you complete it on budget and on time, I think ... and also the client satisfaction'* *'Success project for me is the success of the project and you win (the) trust of the client and award (a) new contract with him'* *'I guess the success is a project deliverable is a way to satisfy the project and the client',*
What makes a project successful	3	1	4	1		*'The people', 'when there is a good environment and the people have compromise and have the enthusiasm'* *' ... to understand the cultural difference so that you can communicate properly to make the success of the project'* *'The project manager personality and his relationship intelligence, organization on the project, the way you search or place positions in place'* *'if (the) client is satisfied by our work by the way the project is managed'* *'It's if after the end of the project the clients come back to us and ask us to ... repeat to another, another project for him and this is (the) proof (that) we reached (achieved) the success with the previous project, yes'*
Project success and Iron Triangle	3	1	4	1	Sufficiency	*'You need more parameters'* *'with the more parameters that you take in the equation to have the better approach'* *'It's not sufficient'* *'It's efficient I don't think so'* *'I think they are still the core of the success in a project.' '... in a very simple project in which you can use just the three ...'*
Project success and Iron Triangle	3	1	4	1	Extra perimeters required	*'You need to add risk on that because (the) risk is a factor (that) will make you able to choose between the three factors'* *'Environmental issues or you can say exterior issues'* *'Ten-knowledge areas, focus areas need to be considered in the assessment of the success of the project'* *'Ten knowledge areas (scope, time, cost, resources, stakeholders, quality, risk, procurement, communication and integration) So, all these must be, in my opinion, be taken into consideration, evaluation, and assessment of the success'* *'you need all of these soft skills and leadership and stakeholder management'* *'... I think in a very complex project then potentially yes, you would need to add in more factors ...'*
Complexity/complex construction project	**3**	**1**	**4**	**1**		*'Complexity is not only linked to the technique, aspects, technical aspects but also to (the) uncertainty of the project'* *'I think complexity is totally split with the technical issues, it's not technical issues that makes a complex project, it's much more, how you manage your project'* *'What is more complex for the project manager and complex project it's more that you have to manage all these people for same working together to achieve (the) same goal'* *'A complex project for me something that involves many different elements including many different stakeholders or many different finances, how is it in terms of finance, many different elements of the project itself '* *'so an overall complex project for me is something that involves many different elements which don't all work together and you got to try to make them fit together to get the end results'*

PD, project director; DPD, deputy project director; PM, project manager; OM, O&M manager; O&M, operations and maintenance.

constraints of the Iron Triangle as adequate in defining project success? (iii) How do project practitioners perceive complex construction projects as successful projects? This study has found that project practitioners perceive a small number of CSFs in contrast to the large lists of CSFs from which respondents participating in the questionnaire surveys are requested to choose or rank. Further, the CSFs perceived by the project practitioners in this study are significantly different from the constituents of the 10 CSF list proposed by Pinto and Slevin (1987), suggesting the prevalence of a research gap with regard to finding the updated list of CSFs, apart from testing the current CSFs lists through quantitative questionnaire surveys in different contexts and performing the research considering limited aspects of construction projects. The traditional constraints of the Iron Triangle, though important, are yet considered inadequate in defining project success, and project professionals are seen as relying more on other indicators for defining a project as a success. Complexity/complex projects are perceived in terms of a large number of interfaces/stakeholders, complex working systems/tools, complex communication, and uncertainty.

The present empirical study contributes a theoretical analysis to the project management literature by laying an incremental groundwork for the development of a common understanding of CSFs as well as the leveraging of project success in a way that would facilitate effective decision making during the project's life cycle. It will also help project practitioners, other stakeholders, and policymakers to understand the relative importance of CSFs for project success.

6 Limitations and directions for future research

The main limitation of this qualitative study lies in the fact that, while such studies typically require the population of respondents to be drawn from a large sample of project professionals so as for their results to be imbibed with a fair degree of representativeness, only a small sample size was used in the present study. We further propose more in-depth interviews with a wider audience in the construction industry to ascertain whether the project practitioners perceive only a small number of CSFs during the project execution works in contrast to the large CSFs lists presented in questionnaire surveys. Obtaining such confirmation would increase the credibility of the present study, and allow determining whether the initial findings of this qualitative study find similarity or even corroboration across a larger sample of stakeholders. Another limitation of this study is the focus on construction projects, though the findings can be generalised to other project-based industries but may not be directly applicable (for instance as in the case of software projects); therefore, the research needs to be expanded to other industries to determine the consistency of the results. This will be valuable because this would help to bridge the gap between the construction industry and research academia. Further, it will help project professionals in enhancing the likelihood of greater construction project success.

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Tab. A1: CSFs identified in previous studies.

CSF dimension/scale item	Identified scientific contributions
Project management factors dimension	
Development of a good project plan	Chan et al. 2004; Toor and Ogunlana 2010; Gudienė et al. 2013a; Ihuah et al. 2014; Maghsoodi and Khalilzadeh 2017; Altarawneh and Samadi 2019
Adequate use of communication among project participants/communication	Pinto and Slevin 1987; Sanvido et al. 1992; Cheng et al. 2000; Nguyen et al. 2004; Phua and Rowlinson 2004; Fortune and White 2006; Andersen et al. 2006; Espinosa et al. 2006; Yu et al. 2006; Jha and Iyer 2007; Toor and Ogunlana 2008; Tabish and Jha 2012; Cserháti and Szabo 2014; Cheong and Mustaffa 2017; Langston et al. 2018; Sinesilassie et al. 2019; Altarawneh and Samadi 2019; Moradi et al. 2020
Clarity of project goal to the project team	Ashley et al. 1987; Pinto and Slevin 1987; Chan et al. 2004; Dvir et al. 2006; Yu et al. 2006; Toor and Ogunlana 2008; Cserháti and Szabó 2014; Langston et al. 2018; Altarawneh and Samadi 2019; Jitpaiboon et al. 2019
Effective project monitoring and control system/monitoring and feedback	Ashley et al. 1987; Pinto and Slevin 1987; Chua et al. 1999; Chan et al. 2004; Iyer and Jha 2006; Jha and Iyer 2007; Toor and Ogunlana 2008; Jha and Chockalingam 2011; Tabish and Jha 2011; Gudienė et al. 2013a; Hwang and Lim 2013; Cserháti and Szabó 2014; Ihuah et al. 2014; Maghsoodi and Khalilzadeh 2017; Langston et al. 2018; Sinesilassie et al. 2019; Altarawneh and Samadi 2019; Moradi et al. 2020
Project team-motivation	Chua et al. 1999; Hwang and Lim 2013; Kog and Loh 2012; Inayat et al. 2012; Gudienė et al. 2013b; Hwang and Lim 2013; Altarawneh and Samadi 2019
Effective partnering among project participants/working relationship among stakeholders/maintaining good relationships between parties	Nicolini 2002; Chua et al. 2003; Chan et al. 2004; Nguyen et al. 2004; Jha and Iyer 2006; Toor and Ogunlana 2008; Nguyen et al. 2004; Tabish and Jha 2011; Meng 2012; Cheong and Mustaffa 2017; Sinesilassie et al. 2019; Negash and Hassan, 2020
Awareness of and compliance with rules and regulations	Belassi and Tukel 1996; Cheung et al. 2012; Tabish and Jha 2011
Clear project aims and objectives	Morris and Hugh 1986; Pinto and Slevin 1987; Pinto and Prescott 1988; Belassi and Tukel 1996; Dvir et al. 1998; Clarke 1999; Qiao et al. 2001; Westerveld 2003; Nguyen et al. 2004; Fortune and White 2006; Toor and Ogunlana 2008
Clear objectives and scope	Chan et al. 2001; Nguyen et al. 2004; Yu et al. 2006; Toor and Ogunlana 2008; Elwakil et al. 2009; Inayat et al. 2015; Kog and Loh 2012; Hwang and Lim 2013; Asgari et al. 2018; Sinesilassie et al. 2019; Moradi et al. 2020
Continuing involvement of stakeholders in the project/stakeholder involvement	Nguyen et al. 2004; Bourne and Walker 2008; Andersen et al. 2006; Aaltonen et al. 2008; Chinyio and Akintoye 2008; Frodell et al. 2008; Olander and Landin 2008; Ward and Chapman 2008; Gudiene et al. 2013; Maghsoodi and Khalilzadeh 2017; Langston et al. 2018; Hasan and Jha 2019; Jitpaiboon et al. 2019; Moradi et al. 2020; Negash and Hassan, 2020; Anilkumar and Banerji 2021
Planning/carefully planning and scheduling project implementation	Ashley et al. 1987; Barry and Randholph 1988; Sanvido et al. 1992; Belassi and Tukel 1996; Clarke 1999; Tam 1999; Levy 2002; Dvir et al. 2003; Chan et al. 2004; Nguyen et al. 2004; Yang 2006; Toor and Ogunlana 2008; Inayat et al. 2015; Kog and Loh 2012; Hwang and Lim 2013; Langston et al. 2018; Moradi et al. 2020; Negash and Hassan, 2020
Conflict was resolved quickly by project participants/conflict resolution	Cheng et al. 2000; Yang et al. 2009; Yang et al. 2006; Tabish and Jha 2011; Zuo et al. 2018
Goal setting	Pinto and Slevin 1988; Songer and Molenaar 1997; Lim and Mohamed 1999; Nicolini 2002; Nguyen et al. 2004; Fortune and White 2006; Toor and Ogunlana 2010; Cheong and Mustaffa 2017

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Table A1. Continued.

CSF dimension/scale item	Identified scientific contributions
Supervision level	Langston et al. 2018; Negash and Hassan, 2020
Project management practices/methodologies/methods/tools	Jugdev et al. 2013; Joslin and Müller 2015; Langston et al. 2018; Jitpaiboon et al. 2019; Langston et al. 2018
Client responsiveness	Ghanbaripour et al. 2018
Human factors dimension	
PM's competency/PM's technical and administrative competency	Pinto and Slevin 1987; Barry and Randolph 1988; Sanvido et al. 1992; Belassi and Tukel 1996; Munns and Bjeirmi 1996; Dvir et al. 1998; Chua et al. 1999; Lim and Mohamed 1999; Qiao et al. 2001; Kog and Loh 2012; Chua et al. 2003; Westerveld 2003; Chan et al. 2004; Nguyen et al. 2004; Fortune and White 2006; Jha and Iyer 2006; Iyer and Jha 2006; Yang 2006; Yu et al. 2006; Toor and Ogunlana 2008; Toor and Ogunlana 2010; Inayat et al. 2015; Kog and Loh 2012; Tabish and Jha 2012; Gudienė et al. 2013a; Hwang and Lim 2013; Cserháti and Szabó 2014; Davis 2014; Ihuah et al. 2014; Mavi and Standing, 2018; Rolstades et al. 2014; Taherdoost and Keshvarzsaleh 2016; Maghsoodi and Khalilzadeh 2017; Misic and Radujkovic 2017; Tsiga et al. 2017; Asgari et al. 2018; Langston et al. 2018; Mavi and Standing 2018; Sinesilassie et al. 2019; Altarawneh and Samadi 2019; Moradi et al. 2020; Negash and Hassan, 2020
Project team members' competency	Pinto and Slevin 1987; Sanvido et al. 1992; Belassi and Tukel 1996; Chua et al. 1999; Nicolini 2002; Belout and Gauvreau 2004; Chan et al. 2004; Nguyen et al. 2004; Fortune and White 2006; Toor and Ogunlana 2008; Toor and Ogunlana 2010; Gudienė et al. 2013a; Ihuah et al. 2014; Moradi et al. 2020
PM's leadership	Fortune and White 2006; Hyväri 2006; Müller and Turner 2007; Müller and Turner 2010; Ahadzie et al. 2008; Cserháti and Szabó 2014; Ihuah et al. 2014; Andersen et al. 2006; Langston et al. 2018; Altarawneh and Samadi 2019; Ahmed et al. 2021
Project participants' commitments in meeting the project goal	Iyer and Jha 2006; Yu et al.2006; Jha and Iyer 2007; Tabish and Jha 2012; Hwang and Lim 2013; Cserháti and Szabó 2014; Langston et al. 2018; Altarawneh and Samadi 2019; Jitpaiboon et al. 2019
Troubleshooting	Pinto and Slevin 1987; Toor and Ogunlana 2010; Gudienė et al. 2013b; Ihuah et al. 2014; Altarawneh and Samadi 2019
Good coordination between project participants/coordination	Belassi and Tukel 1996; Chan et al. 2004; Jha and Iyer 2007; Tabish and Jha 2012; Gudienė et al. 2013a; Cserháti and Szabó 2014; Ihuah et al. 2014; Asgari et al. 2018; Langston et al. 2018; Sinesilassie et al. 2019; Altarawneh and Samadi 2019; Moradi et al. 2020; Negash and Hassan, 2020
Top management support	Nguyen et al. 2004; Belassi and Tukel 1996; Iyer and Jha 2006; Jha and Iyer 2007; Tabish and Jha 2012; Cserháti and Szabó 2014; Gudienė et al. 2014; Ihuah et al. 2014; Asgari et al. 2018; Langston et al. 2018; Sinesilassie et al. 2019; Altarawneh and Samadi 2019; Jitpaiboon et al. 2019; Moradi et al. 2020; Negash and Hassan, 2020
Decision making effectiveness	Fortune and White 2006; Iyer and Jha 2006; Gudienė et al. 2014; Altarawneh and Samadi 2019; Jitpaiboon et al. 2019
Procurement factors dimension	
Comprehensive contract documentation	Sanvido et al. 1992; Chua et al. 1999; Nguyen et al. 2004; Toor and Ogunlana 2010; Alzahrani and Emsley 2013; Cserháti and Szabó 2014; Maghsoodi and Khalilzadeh 2017; Langston et al. 2018; Altarawneh and Samadi 2019
Competitive procurement process	Chan et al. 2004; Li et al. 2005; Cheung et al. 2012; Altarawneh and Samadi 2019; Negash and Hassan, 2020

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Table A1. Continued.

CSF dimension/scale item	Identified scientific contributions
Transparency in procurement process	Chan et al. 2004; Li et al. 2005; Gudienė et al. 2013a, b; Altarawneh and Samadi 2019; Negash et al. 2019
Appropriate risk allocation and risk sharing	Li et al. 2005; Kog and Loh 2012; Gudienė et al. 2013b; Hwang and Lim 2013; Ihuah et al. 2014; Maghsoodi and Khalilzadeh 2017; Altarawneh and Samadi 2019
Awarding bids to the right designer/ contractor	Nguyen et al. 2004; Toor and Ogunlana 2008; Maghsoodi and Khalilzadeh 2017; Sinesilassie et al. 2018
Project characteristics factors dimension	
Project size and value	Cannon 1994; Belassi and Tukel 1996; Chua et al. 1999; Dissanayaka and Kumaraswamy 1999; Chan and Chan 2004; Chan et al. 2004; Andersen et al. 2006; Dvir et al. 2006; Fortune and White 2006; Hyväri 2006; Ademiluyi 2010; Inayat et al. 2015; Kog and Loh 2012; Alzahrani and Emsley 2013; Gudienė et al. 2013a; Carvalho et al. 2015; Li et al. 2005; Maghsoodi and Khalilzadeh 2017; Tsiga et al. 2017; Langston et al. 2018; Altarawneh and Samadi 2019; Moradi et al. 2020; Negash and Hassan, 2020
Complexity and uniqueness of project activities	
The type of project (new, existing, maintenance)	
The urgency of project outcome	
Density of a project	
Project environmental factors dimension	
Physical environment/natural climates	Chan et al. 2004; Phua and Rowlinson 2004; Park 2009; Tabish and Jha 2012; Gudienė et al. 2013a; Amade et al. 2015; Tsiga et al. 2017; Gunduz and Yahya 2018; Altarawneh and Samadi 2019
Project environment	Taherdoost and Keshvarzsaleh 2016; Rodriguez-Segura et al. 2016
Economic and/or financial problems such as price, local currency value/ economic and financial situation	Qiao et al. 2001; Iyer and Jha 2005; Li et al. 2005; Chan et al. 2010; Yong and Mustaffa 2013; Alzara et al. 2016; Ameyaw and Chan 2016; Duryev et al. 2017; Maghsoodi and Khalilzadeh 2017; Langston et al. 2018; Altarawneh and Samadi 2019; Negash and Hassan, 2020
Bureaucratic interference	Nguyen et al. 2004; Phua 2004; Altarawneh and Samadi 2019
Unexpected geological condition, unexpected prices raise for labour and material	Chan et al. 2004; Gunduz and Yahya 2018; Altarawneh and Samadi 2019
Late delivery of materials and equipment	Doloi et al. 2011; Akogbe et al. 2013; Aziz and Abdel-Hakam 2016; Altarawneh and Samadi 2019.
Shortage of labour	Ugwu and Kumaraswamy 2007; Ogwueleka 2011; Alzahrani and Emsley 2013; Altarawneh and Samadi 2019
Project funding factors dimension	
Adequate funding throughout the project/ adequacy of funding	Nguyen et al. 2004; Phua and Rowlinson 2004; Fortune and White 2006; Inayat et al. 2015; Kog and Loh 2012; Gupta et al. 2013; Hwang and Lim 2013; Liu et al. 2016; Maghsoodi and Khalilzadeh 2017; Asgari et al. 2018; Langston et al. 2018; Maqbool and Sudong 2018; Moradi et al. 2020; Negash and Hassan, 2020
Other factors	
Proper emphasis on past experience	Sanvido et al. 1992; Nguyen et al. 2004; Alzahrani and Emsley 2013; Langston et al. 2018
National culture, demographic profile of the respondents	Park 2009; Al-Tmeemy et al. 2011; Martens et al. 2018; Chidambaram & Tamilmaram, 2020

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Table A1. Continued.

CSF dimension/scale item	Identified scientific contributions
Organisation structure	Belassi and Tukel 1996; Chua et al. 1999; Andersen et al. 2006; Chileshe et al. 2005; Young and Samon 2008; Gupta et al. 2013; Misic and Radujkovic 2017; Tsiga et al. 2017; Moradi et al. 2020
Qualified and experienced project management	Maghsoodi and Khalilzadeh 2017
Ongoing consultation with the project employer	Maghsoodi and Khalilzadeh 2017
Regulations and political or economic and social issues	Maghsoodi and Khalilzadeh 2017; Negash and Hassan, 2020
Pre-project planning and clarity in scope	Tabish and Jha 2011; Sinesilassie et al. 2019; Jitpaiboon et al. 2019
Good quality control	Pinto and Slevin 1987; Chan and Kumaraswamy 1996; Lim and Mohamed 1999; Love et al. 2000; Qiao et al. 2001; Chua et al. 2003; Chan et al. 2004; Nguyen et al. 2004; Yang 2006; Alaghbari et al. 2007; Toor and Ogunlana 2008; Nguyen et al. 2009; Keng and Hamzah 2011; Tabish and Jha 2011
Up-to-date technology utilisation/ advanced technologies/use of IT tools	Chan et al. 2004; Nguyen et al. 2004; Toor and Ogunlana 2008; Gupta et al. 2013; Kang et al. 2013; Cheong and Mustaffa 2017; Negash and Hassan, 2020; Cheng et al. 2021
Approved technology used	Chua et al. 2003; Westerveld 2003; Yang 2006; Le-Hoai et al. 2008; Toor and Ogunlana 2008; Nguyen et al. 2004
Owner's competence	Iyer and Jha 2006; Asgari et al. 2018
Favourable working conditions	Iyer and Jha 2006; Langston et al. 2018; Negash and Hassan, 2020
Contractor's company characteristics, technical and professional ability/ competence and experience	Alzahrani and Emsley 2013; Asgari et al. 2018; Langston et al. 2018; Negash and Hassan, 2020
Design expertise design efforts/ variations in designs and drawings	Sanvido et al. 1992; Chan et al. 2001; Chua et al. 2003; Le et al. 2008; Langston et al. 2018; Moradi et al. 2020; Negash and Hassan, 2020
Identifying and analysing possible conflicts and coalitions among stakeholders	Cheng et al. 2000; Chan and Chan 2004; Yang et al. 2009
Fast and effective problem solving	Pinto and Prescott 1988; Sanvido et al. 1992; Belassi and Tukel 1996; Cheng et al. 2000; Chan et al. 2001; Chan et al. 2002; Levy 2002; Chua et al. 2003; Chan et al. 2004; Chan and Chan 2004; Yang 2006; Le et al. 2008; Toor and Ogunlana 2008; Nguyen et al. 2009
Availability of resources	Nguyen et al. 2004; Alzahrani and Emsley 2013; Maghsoodi and Khalilzadeh 2017; Sinesilassie et al. 2019; Negash and Hassan, 2020
Education and training	Negash and Hassan, 2020
Formal dispute resolution process	Toor and Ogunlana 2008; Inayat et al. 2012; Kog and Loh 2012
Legal environment/legal expertise	Langston et al. 2018; Negash and Hassan, 2020
Material and equipment	Negash and Hassan, 2020
Mutual trust among project stakeholders	Langston et al. 2018
No major changes in scope of work during construction	Bajari and Tadelis 2001; Broome and Perry 1995; Sinesilassie et al. 2019

(*Continued*)

Table A1. Continued.

CSF dimension/scale item	Identified scientific contributions
Project cultural fit	Langston et al. 2018
Regular quality control and quality assurance systems	Langston et al. 2018; Sinesilassie et al. 2019
Issues on project (client/customer specific, cost/quality, personal, industry related, etc.) and resolution mechanism	Jha and Iyer 2006; Gudienė et al. 2013a; Davis 2016; Hasan and Jha 2019; Ahmed et al. 2021
Flexibility	Shahu et al. 2012; Langston et al. 2018
Teamwork	Moradi et al. 2020
Political environment	Chan et al. 2004; Phua and Rowlinson 2004; Andersen et al. 2006; Fortune and White 2006; Tsiga et al. 2017; Maqbool and Sudong 2018; Moradi et al. 2020
Accurate and reliable estimates of project costs	Maghsoodi and Khalilzadeh 2017
Skilled workers	Langston et al. 2018; Negash and Hassan, 2020

Source: Kumar et al. (2021) and authors' compilation.
CSF, critical success factor; PMs, project managers.