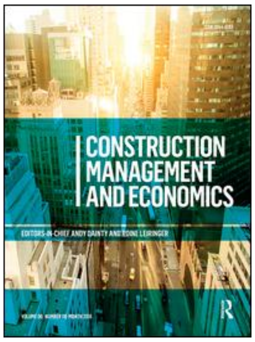

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Influence of risk mitigation measures on international construction project success criteria – a survey of Indian experiences

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ABSTRACT

Despite globalisation bringing diverse opportunities for construction firms from developing countries, executing international construction projects entails many risks. Several past studies illustrate the risks faced by firms in international construction projects and recommend various risk mitigation measures without revealing their effect on project success criteria. In order to fill this knowledge gap, this study aims to test the influence of identified risk mitigation measures on project success criteria. To achieve this, nine risk mitigation measures and three project success criteria—cost performance, schedule performance and firm's performance—were identified through a literature review. After verifying the identified risk mitigation measures and project success criteria with a preliminary study, a questionnaire was administered to experts who possess adequate knowledge in international construction projects. The collected data from 105 questionnaires were analyzed, grouped and modelled using factor analysis and structural equation modelling (SEM). Application of factor analysis to identify the correlated risk mitigation measures extracted three risk mitigation factors, namely pre-project planning, local participation and contract selection. Furthermore, the influence of risk mitigation factors on project success criteria is hypothesized and tested using SEM. Amongst the identified risk mitigation factors, local participation emerges as the most influencing factor on project success criteria followed by contract selection and pre-project planning. The generated model would enable construction firms from India and similar developing countries to focus on identified risk mitigation factors to achieve improved project success criteria and project management success.

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KEYWORDS
International construction; risk management; risk mitigation measures; structural equation modelling; factor analysis; questionnaire survey

Introduction

International construction projects are attracting firms from countries with emerging markets, such as Brazil, China, India, Korea, Malaysia, Turkey and Vietnam, to meet developing nations' infrastructure demands (Bon and Crosthwaite 2001, Ofori 2003, Lee *et al*. 2011). Some examples are Brazilian firms' expansion to neighbouring nations in South America, Chinese firms dominant presence in Africa (Kadry *et al*. 2017) and Indian firms growing presence in the Gulf region. The construction firms from these countries have competitive advantages over others through a culture of hard work, low-cost labour availability and favourable relations with certain countries (Lee *et al*. 2011).

International construction projects are beneficial for construction firms not only in expanding their territory but also in taking advantage of the growing foreign economy (Al-Sabah *et al*. 2014) and to overcome the threats associated with domestic market fluctuations (Kadry *et al*. 2017). However, international construction projects bring additional risks not present in domestic construction projects and the construction firms find these risks threatening when entering the international market (Han *et al*. 2008). For this reason, an appropriate risk management process is needed to meet the project success criteria and to evade a higher-level risk exposure during the international construction project execution phase.

Risk management is an iterative process, which is initiated by the identification of possible risks associated with the construction project. Risk identification is followed by risk assessment in which the potential impact of identified risks is evaluated. Once the project risks have been identified and assessed, suitable risk mitigation measures or risk responses are formulated. The project performance usually depends on appropriate risk mitigation measures adopted to

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Table 1. Export contracts carried out by Indian companies (data source: EXIM Bank 2018).

Financial year (April to March)	Number of contracts secured: Turnkey	EPC	Consultancy and supply contract	Total	Number of countries	Total number of companies	Total contract amount in US$ (Million)
2011–12	26	25	2	53	23	28	3531.3
2012–13	52	15	18	85	38	47	3724.9
2013–14	48	11	16	75	35	40	5245.9
2014–15	43	24	38	105	40	56	7651.3
2015–16*	55	18	22	95	39	50	3472.2

*Incomplete data.

mitigate the identified risks (Dikmen *et al.* 2007). However, in international construction projects, risk mitigation measures are not so well developed (Kapila and Hendrickson 2001). Few researchers, such as Deng and Low (2014), Han *et al.* (2008) and Wang *et al.* (2004), have highlighted the importance of systematic risk management in international construction projects. Although such studies make a valuable contribution to international risk management studies, they do not adequately reveal the interaction between risk mitigation measures and their influence on project success criteria or project management success. In order to fill this research gap, this study has focussed on grouping the identified risk mitigation measures called risk mitigation factors, and finding their influence on project success criteria in international construction projects executed by Indian construction firms.

In this study, the important risk mitigation measures adopted in international construction projects and important project success criteria were initially identified from a literature review. After verifying the identified risk mitigation measures and project success criteria through a pilot study, a questionnaire survey approach was adopted for data collection from case projects that were executed by Indian construction firms (contractors and consultants) in the international market. To identify the influence of risk mitigation measures on project success criteria, statistically correlated risk mitigation measures were grouped using factor analysis and termed risk mitigation factors. Subsequently, a hypothesis was developed to test the risk mitigation factors' positive influence on project success criteria using structural equation modelling (SEM). The quantitative results obtained from SEM were examined to illustrate the effectiveness of the identified risk mitigation factors on project success criteria.

Indian construction industry and its international presence

The construction industry in India is the second largest employment provider and contributes to 8% of India's gross domestic product (Tripathi and Jha 2018). Indian construction firms are growing rapidly and expanding towards the international market for further growth (Jha and Devaya 2008). For example, in the financial year (FY) 2014–15, a total of 56 Indian firms have secured 105 contracts of worth US$7651.3 million in 40 countries (EXIM Bank 2018). These contracts include turnkey projects, engineering procurement and construction (EPC) projects, consultancy, and material supply in foreign countries. The increased trend for project and service exports from Indian firms are illustrated in Table 1.

The data shows that there is an upward trend in construction project exports by Indian construction firms in the international market. As Indian firms ventured into more than 96 countries (EXIM Bank annual reports – 2010 to 2014) and possessed adequate familiarity in the international market, this study can considerably contribute to international market aspirants, particularly for firms from India and similar developing countries.

Literature review

Risk is defined as the chance of an adverse event that depends on the circumstances (Mills 2001). Risk management is a systematic approach to dealing with risk and is a rational chain of practices taken by decision-making agents to keep the project implementation moving in a safe and effective manner (Dandage *et al.* 2018). The risk management process is a vital part of project management that involves identifying, analyzing and assessing various risks to recognize suitable mitigation measures. The construction sector has long been associated with various risks. During various phases of a construction project, construction firms are required to come across a certain level of risk due to unexpected events (Stephen and Picken 2000). If these risks are not assessed and managed effectively, they can affect project performance and the construction firm's long-term market sustainability (Ahsan and Gunawan 2010).

Table 2. Risks in international construction projects and their references.

Risk level	The risks in international construction projects	References
Country	Bureaucracy obstacles in the host country	Eybpoosh *et al.* (2011), Liu *et al.* (2016), Yildiz *et al.* (2014), Zhi (1995)
	Not having a good relationship with the host government	Alon and Herbert (2009), Ashley and Bonner (1987), Bing *et al.* (1999), Deng *et al.* (2014), Han *et al.* (2008)
	Host country government instability	Al-Sabah *et al.* (2014) El-Sayegh (2008), Eybpoosh *et al.* (2011), Jha and Devaya (2008)
	Import and export restrictions in the host country	Al-Sabah *et al.* (2014), Bing *et al.* (1999), Liu *et al.* (2016), Wang *et al.* (2004), Zhao *et al.* (2013)
	The poor legal system of the host country	Al-Sabah *et al.* (2014), Eybpoosh *et al.* (2011), Jha and Devaya (2008), Liu *et al.* (2016), Yildiz *et al.* (2014)
	Increased influence of terrorism and antisocial elements	Alon and Herbert (2009), Eybpoosh *et al.* (2011), Kadry *et al.* (2017), Xiaopeng and Pheng (2013)
	Language barrier	Al-Sabah *et al.* (2014), Bing *et al.* (1999), Liu *et al.* (2016), Zhi (1995)
Market	Poor local market condition	Alon and Herbert (2009), Deng *et al.* (2014), Jha and Devaya (2008), Zhi (1995)
	International economic instability	Deng *et al.* (2014), Xiaopeng and Pheng (2013), Zhi (1995)
	Dispute(s) with local construction labour	Al-Sabah *et al.* (2014), El-Sayegh (2008), Gunduz *et al.* (2013), Zhi (1995)
	Restrictive labour markets	Bing *et al.* (1999), Kadry *et al.* (2017), Liu *et al.* (2016), Wu *et al.* (2017), Yildiz *et al.* (2014), Zhi (1995)
	Frequent currency fluctuation	Al-Sabah *et al.* (2014), El-Sayegh (2008), Eybpoosh *et al.* (2011), Wang *et al.* (2004), Zhi (1995)
	Fluctuation in the price of construction materials	Eybpoosh *et al.* (2011), Ling and Lim (2007), Kadry *et al.* (2017), Liu *et al.* (2016)
	Nonavailability of quality materials	El-Sayegh (2008), Zhao *et al.* (2013)
Project	The incompetence of other stakeholders	El-Sayegh (2008), Gunduz *et al.* (2013), Han *et al.* (2007), Jha and Devaya (2008), Wang *et al.* (2004)
	Improper project management	Jha and Devaya (2008), Zhang and Zou (2007)
	Low productivity of the labour	Eybpoosh *et al.* (2011), El-Sayegh (2008), Jha and Devaya (2008), Kadry *et al.* (2017), Yildiz *et al.* (2014),
	Untimely payment from the client	El-Sayegh (2008), Liu *et al.* (2016), Wang *et al.* (2004), Zhi (1995)
	Tight project schedule	El-Sayegh (2008), Liu *et al.* (2016) , Wu *et al.* (2017), Zou *et al.* (2007)
	Entering into non-standard contracts	Zhi (1995), Liu *et al.* (2016)
	Inexperience in similar works	Deng *et al.* (2014), Gunduz *et al.* (2013), Kadry *et al.* (2017)
	The complexity of the project	El-Sayegh (2008), Eybpoosh *et al.* (2011), Han *et al.* (2007), Xiaopeng and Pheng (2013), Yildiz *et al.* (2014)

The risk in international construction projects

International construction is when a construction company resident in one country performs work in another country (Ye *et al.* 2018). Every construction activity in international construction projects attracts some risk and they are primarily ordered into three risk levels, namely, the country, market and project levels (Zhi 1995, Liu *et al.* 2016, El-adaway *et al.* 2018). For example, Hastak and Shaked (2000) classified 73 risks into these three levels. According to Deng *et al.* (2018), the country-level risk is also called political risk, which includes threats from political activities, government intervention and social intervention. El-Sayegh (2008) presented a risk breakdown structure with 42 risks at project levels and subdivided them as internal and external risks. Some studies also focus on more specific categories of risks in international construction projects. For example, Alon and Herbert (2009), Al-Khattab *et al.* (2007), Deng *et al.* 2018 and Xiaopeng and Pheng (2013) examined the political risks in international construction projects. Han *et al.* (2004) focused on financial portfolio risk management for international projects. Table 2 shows a few important identified risks in international construction projects at different levels. All these studies shared a common limitation in that they focused mainly on risk identification and they have not presented any mitigation measures for the identified risks.

Past studies on risk mitigation measures in international construction projects

Although international construction projects are sensitive to various risks, possible adverse events can be mitigated through adequate management actions (Ashley and Bonner 1987). For example, Ling and Hoi (2006) attempted to identify the risks faced by construction firms in Singapore while executing construction projects in India and explored various risk mitigation measures adopted by them. Through in-depth interviews, Singaporean experts proposed risk mitigation measures such as adequate insurance in addition to careful planning and management to overcome political, cultural, social and market risks. In addition, for successful operation, foreign firms were recommended to respect local culture and practices.

The most common practical mitigation measures recommended to overcome the project, market and country level risks are establishing a joint venture with a renowned local partner, a proper feasibility study, obtaining insurance for political risks, adequate contract clauses and maintaining a good relationship with the local government (Wang *et al*. 2004). Similarly, the possible counteractions to cope with international project risks are an escalation clause in the contract, a price contingency in the bid, appropriate project financing, a forward contract and hedging, insurance and adequate safety and quality assurance plan (Al-Bahar and Crandall, 1991). In addition, careful planning and choice of a dispute resolution method clause in the contract are key factors in controlling project risks during the contract formation stage (Gad *et al.* 2013).

Kapila and Hendrickson (2001) attempted to present strategies to minimize foreign exchange risk and manage foreign exchange dealings associated with international construction projects by interviewing construction professionals. According to their study, the crucial measures to overcome financial risk in international construction projects are forward exchange contracts and borrowing strategies. Ling and Lim (2007) recognized that financial and economic risks could be mitigated through suitable subcontracting, adequate bidding strategy and proper pre-evaluation. Both these studies are focussed on mitigation measures for economic and financial risks.

Using suitable early cautionary and monitoring approaches, firms can be well prepared for the possible challenging conditions associated with political risks in the international market. Deng *et al.* (2014) suggested few possible preparations for handling political risks, which include (1) outlining the political risk action plans, (2) negotiating with the host government for corresponding project guarantees, (3) a provision for political risk insurance, and (4) allocating additional contingency funds.

Apart from the above, Lee and Schaufelberger (2013) presented risk management strategies for BOT (built operate and transfer) projects in the East Asia and Pacific region, and several researchers (Zhang and Zou 2007, Zhao *et al.* 2013, Hwang *et al.* 2016) have presented risk management strategies for the joint venture (JV) projects. But in all these studies, considerably less attention was devoted to examining the influence of the identified risk mitigation measures on project success criteria, especially in international construction projects.

From all the above studies and peer-reviewed literature, nine risk mitigation measures relating to international construction projects were identified in this study. Table 3 illustrates the list of risk mitigation measures and their explanations.

Research gap

From the literature review, it is apparent that in most studies, priority has been given to identifying the various risks in international construction projects and their common mitigation measures. However, a quantification of the dependencies of risk mitigation measures on project success criteria has not been found in any of these studies. It is essential to fill this gap by empirically examining the relationships between risk mitigation factors (grouped risk mitigation measures) and the project success criteria of international construction projects when measured against different performance criteria.

Furthermore, the focus of the previous studies was mainly on a particular developing country or a region, but only a few researchers have drawn attention to Indian firms in international construction projects. According to Isa *et al.* (2014) and Tripathi and Jha (2018), the factors responsible for the success of a construction firm in one country may or may not be the same as that of another construction firm in another country. Therefore, it was necessary to identify the vital risk mitigation factors and their influence on project success criteria for Indian construction firms executing international construction projects. Though this study is based on the data collected from Indian firms, neighbouring and similar developing countries can make use of this empirical study.

Project success criteria

Project success is defined as the extent to which predefined project objectives are achieved (Ozorhon *et al.* 2008). Various researchers (Cooke-Davies 2002, Nguyen *et al.* 2004) have divided project success into project success criteria and project success factors. Success criteria are the indicators by which success or failure of a project or business will be judged, whereas success factors are the inputs to the management system that lead directly or indirectly to the success of

Table 3. Risk mitigation measures.

ID	Risk mitigation measures	Explanation	References
RM1	Offer more local employment	Local employees often have related work experience and know more about the local conditions and safety regulations. Therefore, the preference of local employment can be useful to a project, especially when the firm is in its establishment stage in a particular host country.	Bing *et al.* (1999), Gao *et al.* (2016)
RM2	Select efficient subcontractors	Efficient subcontractors and material suppliers ensure a smooth progress of any project. Also, the resourceful subcontractor can help to execute the whole construction process in a financially sustainable environment.	Akintoye and MacLeod (1997), Bing *et al.* (1999), Lee *et al.* (2018), Ulubeyli *et al.* (2017)
RM3	Maintaining good relation with local government/ group	International firms benefit from virtuous connection with the host government and power group by: (1) gaining vital and latest information of the project and host country (2) extent of natural resource availability (3) preventing the host government from discerning the firm, and (4) overcoming the risk of delay in approvals and permits	Deng *et al.* (2014), Gad *et al.* (2013), Liu *et al.* (2016), Zhang and Zou (2007)
RM4	Insure everything that is insurable	Insurance is an equitable transfer of the risk of a loss, from one entity to another, in exchange for an insurance rate called premium. For international construction projects, investment insurance plays an important role in loss compensation, risk prevention, and convenient financing.	Akintoye and MacLeod (1997), Al-Bahar and Crandall (1991), Bing *et al.* (1999), Lee and Schaufelberger (2013), Wang *et al.* (2004)
RM5	Select a suitable contract	An engineering contract is a legal linkage between project owner and executing firm, who are bound together through the allocation of risk and profit in the contract. Entering into the standard contract system is important for fair risk allocation amongst the project participants that includes options for dispute resolution.	Bing *et al.* (1999), Ozorhon *et al.* (2006)
RM6	Carryout proper feasibility study of the project	The information dearth during the early phases of international construction projects can lead to poor contract management and induce damage to the project performance. So, the collection of early-stage information is worthy to assess the unfavourable contract clause, supply management, resource procurement, technical aspects, local custom and cultural condition of the host country.	Bing *et al.* nd Tiong (1999) ; Hsueh *et al.* (2007), Jha and Devaya (2008)
RM7	Allocate contingency for uncertainties	Contingency is crucial for successfully managing projects since it provides a buffer against risk development. Contingency can be thought as a construction firm's estimated value of the extraordinary risks they may encounter in a project. The extraordinary risk would be those unforeseen conditions, which are not covered by bonds, insurance, or the contract.	Al-Bahar and Crandall (1991), Han *et al.* (2008), Smith and Bohn (1999)
RM8	Keep proper financial options/ monetary support	Adequate preplanning and viable financial options are vital to manage economic and financial risks and it avoids any adverse project performance.	Lee and Schaufelberger (2013)
RM9	Establish Joint Venture (JV) with renowned local partners	The joint venture (JV), a distinct type of strategic alliance, offers an opportunity to combine the distinct competency and complementary resources of participating firms. In international construction projects, international firms establish partnerships with the known local firm to gain knowledge of local business practice, custom, economy, and politics to reduce risks in unfamiliar conditions of the host country, which can considerably improve the project success.	Bing *et al.* (1999), Wang *et al.* (2004)

the project or business (Nguyen *et al.* 2004). The criteria for project success are generally considered to be cost, time and performance (de Wit 1988, Wu *et al.* 2017). In this research, the project success criteria are measured in terms of achieving project targets, such as a project being on schedule (schedule performance) and within budget (cost performance), along with a firm's performance. Firm performance comprises client satisfaction, the firm's market dominance and acceptance of the firm (Al-Sabah *et al.* 2014, Deng *et al.* 2014, Shi *et al.* 2016).

Research method

The overall research method consists of five steps. These steps are explained in the following sub-sections.

Step 1: Preliminary interview

In step one, the risk mitigation measures listed in Table 3 and project success criteria were discussed in detail with three experts, who possess more than 20 years of experience in international construction projects, to check their suitability for international projects. These experts were selected based on their vast knowledge in executing international construction projects and their availability. After two rounds of personal discussion with each expert and a few recommendations, the experts opined that the list of risk mitigation measures and project success criteria were generally suitable and no further modification was needed.

Step 2: Data collection using a questionnaire survey

Data collection was done using a questionnaire survey. The questionnaire contained four parts: part 1 contained the respondent's details, including international project experience; part 2 included the project success criteria, such as cost, schedule and firm's performance; part 3 consisted of various risk variables; and part 4 comprised identified risk mitigation measures.

Based on the respondent's international experience, they were asked to choose an international construction project of their choice in which they participated. This is referred to as a choice project in the study. In part 2 of the questionnaire, the respondents were asked to weight the cost, schedule, and firm's performance on a scale of 1 to 9 for the choice project. In part 4 of the questionnaire, the participants were asked to weight the impact of the nine identified risk mitigation measures on the success criteria of the same project on a scale of 1 to 9 (least impact to extremely high impact). A nine-point scale has been used in the past for identifying interrelationship among factors/groups in studies by Chen *et al.* (2012) and Tabish and Jha (2012). To provide enough sensitivity and create opportunities for the response set, a higher number of scale points were preferred (Tabish and Jha 2011).

To test the accuracy and identify the understanding of the questionnaire, a pilot study was carried out with three industry experts who had more than 20 years of international project experience. Among the three experts, two experts had rendered their services during the discussion on risk mitigation measures and project success criteria in step one. After incorporating the suggestions received from the experts, the questionnaire was administered through personal meetings and emails with experts who possess first-hand knowledge in international construction projects accomplished by Indian firms. The Indian construction industry (contracting and consulting firms) executing international projects were the population for this study and an international construction project is a unit of analysis. The sample questionnaire is attached as supplementary material along with this paper.

A total of 105 responses were received out of 200 circulated questionnaires. All respondents have experience in international construction projects executed by Indian companies. Of the 105 responses, 57 responses were received via e-mail and 48 were obtained via personal meetings. The sample size of 105 is comparable or larger than in previous similar studies by Liu *et al.* (2016), Ozorhon *et al.* (2008) and Wong and Cheung (2005). Table 4 depicts the respondents' profile regarding their international experience and their professional roles.

Out of the 105 responses, 97 choice projects were from Asian and African regions, including the Middle East. Thus, the responses appeared heavily weighted toward Africa and Asia. It is essential to ensure that the sample is truly representing the population. From various sources, such as the Export-Import Bank of India's annual reports, construction firms' annual reports, construction firms' official websites, leading construction magazines and personal interaction with the construction firms' representatives, a total of 293 international project details executed by Indian firms were collected randomly. Out of 293 projects, 255 were completed in African and Asian regions. Therefore, the questionnaire responses are representative of the population. Data from similar developing countries, such as China, Korea and Turkey also reveals that top contractors from the respective countries earn more revenue from Asia and African countries, as described in Table 5.

Another important aspect of international construction is the type of client. Out of the 105 responses, 46 case projects were public projects and the rest were private projects. To check the level of agreement between these two response groups, a Spearman's rank correlation (R) test was conducted. The identified R-value of 0.832 is statistically significant at an allowable significance level of 5%. Therefore, there is a significant agreement between the two groups. Thus, the collected responses, as a whole, were used for the analysis.

Step 3: Grouping of risk mitigation measures

For further analysis in the following steps, it is crucial to identify any overlap (i.e. correlation) among identified risk mitigation measures. In some instances in multivariable measurements, the identification and grouping of correlated variables (in this study risk mitigation factors) are necessary to overcome the measurement error (Hair *et al.* 2014). Factor analysis provides the tools for analyzing the structure of the correlations among a number of variables by defining sets of variables that are highly correlated or interrelated, known as factors (Al-Sabah *et al.* 2014, Deng *et al.* 2014, Hair *et al.* 2014). Hence, an attempt was made to group the risk mitigation measures using factor analysis.

The sample size of 105 for nine variables was higher than the required minimum absolute sample size of 50 and more than the recommended sample-variable ratio of 5:1 (Deng and Low 2014, Hair *et al.* 2014), indicating that the sample size was adequate for factor analysis. The reliability of the nine-point scale responses was assessed using Cronbach's alpha (0.845), which is well above the recommended value of 0.7 (Hair *et al.* 2014). Thus, all the data were subjected to the principal component analysis of factor extraction with varimax rotation. Compared to other rotation methods, such as quartimax and equimax, the varimax rotation is preferred as it provides a clearer separation of the factors and tends to have more invariants when different subsets of variables analyzed (Cho *et al.* 2009, Al-Sabah *et al.* 2014, Hair *et al.* 2014).

Regarding the strength of the relationship between the variables, most values in the correlation matrix are larger than 0.3. Bartlett's test of sphericity (χ^2 = 411.37, df = 36, significance level = 0.000) was significant ($p < .05$), and the value of the KMO index (0.840) was above 0.50 (Deng *et al.* 2014; Tripathi and Jha 2017). According to the latent root criterion (Eigenvalues $>$ 1.0), a total of three factors were extracted. The cumulative variance explained was 72.50%, which was higher than the recommended guideline of 60% (Chan *et al.* 2012; Deng and Low 2014). Each of the variables weighed heavily to one of the factors and the loading on each factor exceeded 0.50. The commonality values for the variables extracted from the three factors were above 0.50 (Hair *et al.* 2014). The details of the factor analysis and risk mitigation factors are presented in Table 6. Based on their common and latent properties, the three identified risk mitigation factors were named pre-project planning, local participation and contract selection.

Table 4. Profile of the respondents.

Characteristics	Category	N	Percentage
Respondent's experience in international construction projects	<5 years	28	26.67
	6–10 years	33	31.43
	11–15 years	36	34.28
	>15 years	08	07.62
Respondent's involvement in international construction projects executed by Indian firms	1–3 projects	56	53.33
	3–6 projects	32	30.48
	6–9 projects	11	10.48
	>9 projects	6	05.71
Respondent's profile	Contractor	72	68.57
	Consultant	31	29.53
	Real estate developer	2	01.90
Location	Africa	39	37.14
	Asia	58	55.24
	Europe	4	03.81
	Latin America	2	1.91
	North America	1	0.95
	Oceania and Pacific Islands	1	0.95

Table 5. Revenue of international contractors from 2010 to 2013 in billion US$ (Source: Zhao et al.2017).

Country/ region of the firms	Middle East	Asian countries other than the Middle East	Africa	Europe	USA	Canada	Latin America	Total revenue	Asia and Africa	The percentage in Asia and Africa (%)
China	11.092	22.333	25.655	2.003	0.580	0.073	4.726	66.462	59.080	88.89
Japan	3.020	11.921	0.872	0.488	2.274	0.265	0.581	19.421	15.813	81.42
Korea	19.192	8.176	2.534	0.194	0.392	0.161	1.322	31.971	29.902	93.53
Turkey	5.273	3.327	2.102	6.105	0.02	0	0.095	16.922	10.702	63.24

Table 6. Grouping of identified risk mitigation measures (RMMs).

ID	Risk mitigation measure	Mean value	Standard deviation	Communalities	Factor loading: Pre-project planning	Factor loading: Local participation	Factor loading: Contract selection
RM4	Insure everything that is insurable	7.59	1.44	0.745	0.852		
RM6	Carryout feasibility study	7.53	1.41	0.683	0.790		
RM7	Allocate contingency	7.52	1.48	0.705	0.745		
RM8	Keep proper financial options	7.44	1.77	0.606	0.621		
RM9	Establish JV with locals	7.61	1.63	0.810		0.864	
RM3	Relation with local government and power group	7.49	1.65	0.807		0.862	
RM1	Offer more local employment	7.22	2.47	0.673		0.483	
RM2	Select efficient subcontractor	7.75	1.29	0.835			0.898
RM5	Select suitable contract	7.68	1.41	0.661			0.513
	Variance (%)				32.620	23.39	16.49
	Cumulative variance (%)				32.620	56.01	72.50
	Kaiser-Meyer-Olkin measure of sampling adequacy				0.840		
	Bartlett's test of sphericity						
	Approximate $\chi 2$				411.37		
	Dof				36		
	Significant				0.00		

Step 4: Interrelation among risk mitigation measures and project success criteria—model generation

After identifying the risk mitigation factors, the interrelation between the identified risk mitigation factors and the project success criteria was analyzed using structural equation modelling (SEM). SEM is preferred in this study over other multivariate techniques due to the following advantages.

- SEM can estimate multiple and interrelated dependent variables or target variables together (Chen *et al.* 2012, Hair *et al.* 2014). In this study, the multiple dependent variables are cost performance, schedule performance and firm's performance.
- SEM can simultaneously represent observed and unobserved variables in the relationships and it can correct the measurement errors in the estimation process (Chen *et al.* 2012, Xiong *et al.* 2015). In this study, the risk mitigation factors are unobserved or latent variables.
- SEM can define a model explaining the entire relationship set (Cho *et al.* 2009) and it is helpful in understanding performance algorithms because users can visually and systematically recognize complex relationships (Chen *et al.* 2012).

Due to the above advantages, more studies are emerging that use SEM in the area of engineering, specifically in construction management (Cho *et al.* 2009, Tripathi and Jha 2018). Some of the areas of construction management in which SEM has been used are a study on the effect of project characteristics on construction project performance (Cho *et al.* 2009), the interrelation among critical success factors of construction projects (Chen *et al.* 2012), investigating factors affecting delay in construction projects (Doloi *et al.* 2012), trust and partnering success in construction projects (Wong and Cheung 2005), finding a relationship based on determinants of safety performance in construction projects (Patel and Jha 2016), the interrelation among critical success factors of infrastructure (Shi *et al.* 2016), and so forth. Thus, the available literature supports the soundness and application of SEM. The full concept of SEM is not explained as it is beyond the scope of this study.

According to Cho *et al.* (2009), the three stages used in SEM are (1) defining latent and manifest variables, (2) setting up a hypothesized model and (3) assessing the appropriateness of the hypothetical model and ascertaining the optimum relationship. Thus, in this study, a hypothesized model was developed to test the influence of risk mitigation factors on the project success criteria. The hypothesized model was analyzed using AMOS 21 software, which is used for covariance-based SEM. Hair *et al.* (2014) recommend using covariance-based SEM over variance-based SEM owing to its distinct advantages in terms of their statistical properties. AMOS is preferred as it has a user-friendly user interface platform compared with other available software, such as EQS and LISREL (Oke *et al.* 2012, Xiong *et al.* 2015). The maximum likelihood estimation (MLE) method was used in this study because this is the most common SEM estimation procedure. According to Hair *et al.* (2014), various simulation studies suggest that under ideal conditions, MLE provides valid and stable results even with small sample sizes. Based on the existing literature, the

Table 7. GOF measures.

S.No	GOF measures	Recommended level of GOF measures (Cho *et al.* 2009, Chen *et al.* 2012, Oke *et al.* 2012, Hair *et al.* 2014, Tripathi and Jha 2018)	The value obtained in the model
1	χ^2/dof	1–2	1.620
2	GFI	0 (no fit) to 1 (perfect fit)	0.896
3	IFI	0 (no fit) to 1 (perfect fit)	0.944
4	TLI	0 (no fit) to 1 (perfect fit)	0.923
5	CFI	0 (no fit) to 1 (perfect fit)	0.943
6	RMSEA	$<$0.05 (very good) to 0.1 (threshold)	0.077

sample size of 105 used in this study was adequate for reliable results (Molwus *et al.* 2013, Tripathi and Jha 2018). To estimate SEM, the minimum subject to the variable ratio for assuring the distribution of variables of 5:1, as recommended by Xiong *et al.* (2015), is also fulfilled.

From the hypothesized model, the risk mitigation factors' positive influence on the project success criteria was tested.

1. Null hypothesis (H_0): The path coefficient between risk mitigation factors and project success criteria of an international construction project is not significantly different from zero.
2. Alternative hypothesis (H_1): Risk mitigation factors have a significant positive influence on the project success criteria of an international construction project.

Step 5: Validation of the generated model

The hypothesized model was evaluated for its appropriateness from the results of the covariance structural analysis. Various goodness-of-fit (GOF) measures were used for this purpose. Different criteria have been proposed in the SEM literature by various researchers for assessing the GOF of a specified model (Wong and Cheung 2005, Tripathi and Jha 2018). Every GOF index measures the appropriateness of a model for diverse aspects. From the various fit indices proposed in the literature, the following GOF measures were adopted in this study for validating the relationship between risk mitigation factors and project success criteria.

1. The ratio of Chi-square (χ^2) to the degree of freedom (*dof*) compares the observed covariance matrix with the covariance matrix estimated by assuming that the tested model is correct (Chen *et al.* 2012, Tripathi and Jha 2018).
2. The RMS error of approximation (RMSEA) measures how well the model, with unknown but optimally chosen parameter estimates, would fit the population covariance matrix. (Hooper *et al.* 2008).
3. The comparative fit index (CFI) represents the relative improvement in the fit of the hypothesized model. CFI has many desirable properties, including its relative, but not complete, insensitivity to model complexity. It is among the most widely used indices (Hair *et al.* 2014).
4. The goodness of fit index (GFI). From the variances and covariances accounted for by the model, GFI shows how closely the model comes to replicating the observed covariance matrix (Hooper *et al.* 2008).
5. The incremental fit index (IFI) compares a Chi-square for the model tested to the hypothesized model. It indicates the relative improvement in the fit of the model compared with a statistical baseline model (Tripathi and Jha 2018).
6. The Tucker-Lewis index (TLI) considers a correlation between model complexity and sample size (Patel and Jha 2016; Tripathi and Jha 2018).

Table 7 explains the details and results of various GOF measures of the model. The values obtained for χ^2/dof (1.620), RMSEA (0.077), CFI (0.943), GFI (0.896), IFI (0.944) and TLI (0.923) indicated the appropriateness of the model. Thus, the hypothesized model is recognized as the final model without any modifications, as shown in Figure 1.

Results and discussion

Table 8 lists the standardized path coefficients, standard error, *t*-values, and a significance level of the model. All the standardized estimates are statistically significant ($t > 1.96$) and positive, indicating the relationship between manifest and latent variables. The higher the path coefficient, the more critical the variable or factor. Hypothesis H_1, which assumes that risk mitigation factors have a significant positive influence on the project success criteria of the international construction project is supported because the path

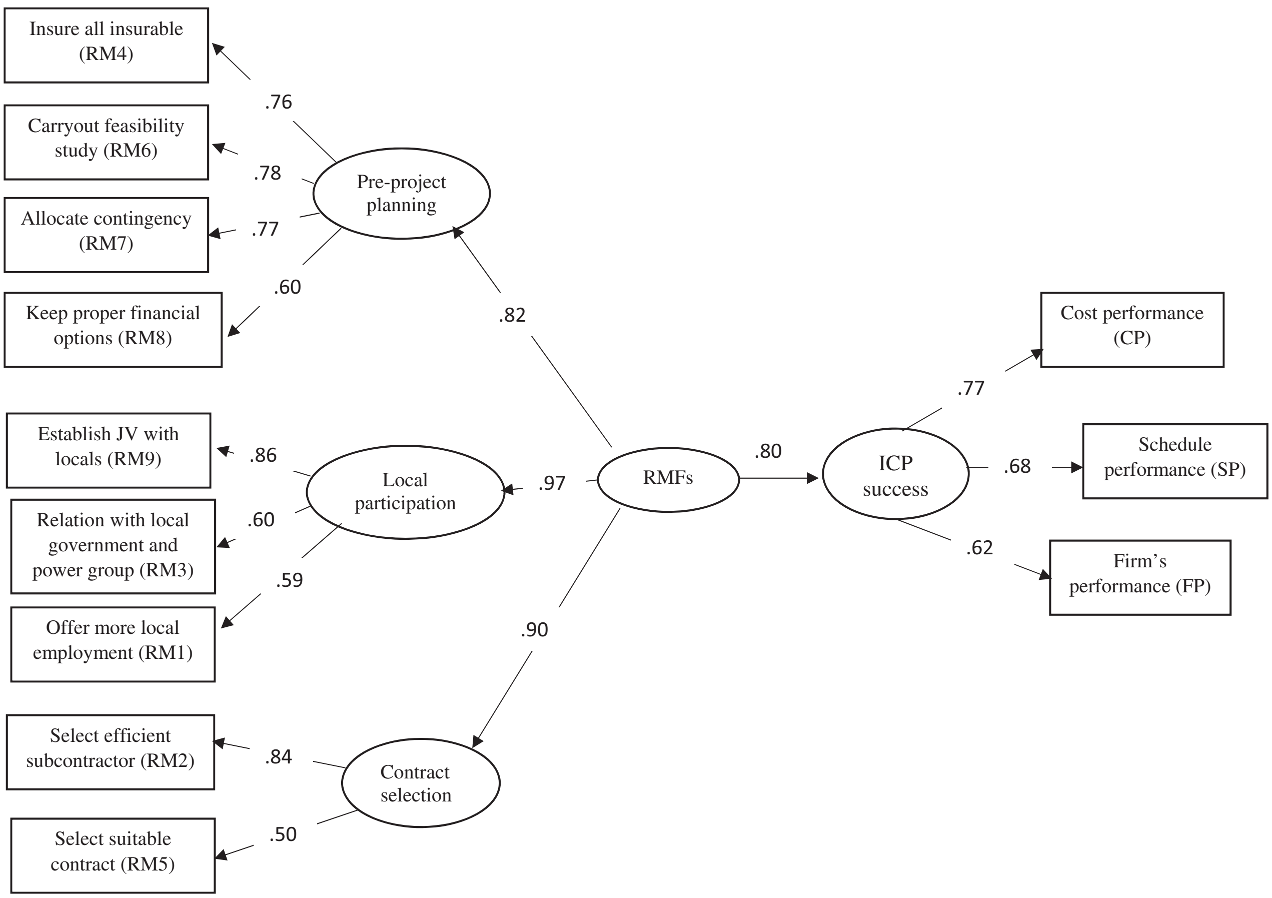

Figure 1. Generated model.

Table 8. Path coefficient.

Path			Unstandardized estimate (B)	Standardized estimate (β)	Standard error (є)	*t* value	Sig(p)
Pre-project planning	⟵	Risk mitigation factor	1	0.819	–	–	–
Local participation	⟵	Risk mitigation factor	2.010	0.974	0.372	5.401	***
Contract selection	⟵	Risk mitigation factor	1.566	0.903	0.300	5.218	***
Project success criteria	⟵	Risk mitigation factor	1.574	0.800	0.336	4.691	***
Keep proper financial options	⟵	Pre-project planning	1	0.597	–	–	–
Allocate contingency	⟵	Pre-project planning	1.185	0.772	0.201	5.896	***
Insure all insurable	⟵	Pre-project planning	1.269	0.755	0.219	5.804	***
Carryout feasibility study	⟵	Pre-project planning	1.410	0.784	0.237	5.94	***
Establish JV with locals	⟵	Local participation	1	0.864	–	–	–
Relation with local government and power group	⟵	Local participation	0.672	0.605	0.108	6.222	***
Offer more local employment	⟵	Local participation	0.643	0.592	0.106	6.067	***
Select a suitable contract	⟵	Contract selection	1.167	0.500	0.255	4.581	***
Select efficient subcontractor	⟵	Contract selection	1	0.839	–	–	–
Cost performance	⟵	Project success criteria	1	0.771	–	–	–
Schedule performance	⟵	Project success criteria	0.521	0.685	0.085	6.141	***
Firm's Performance	⟵	Project success criteria	0.669	0.624	0.118	5.661	***

Note: ***= Sig (*p*) $<$.001.

coefficient of 0.80 is significant at the 0.05 significance level.

When the total, direct and indirect effect of risk mitigation measures and risk mitigation factors on the project success criteria were examined through the SEM model, it was found that three identified risk mitigation factors, local participation, contract selection and pre-project planning, had a direct influence on project success criteria, such as cost performance (path coefficient of 0.77), schedule performance (path coefficient of 0.68) and firm's performance (path coefficient of 0.62), whereas the risk mitigation measures had an indirect influence on the project success criteria of international construction projects. The outcome of the study is briefly explained in the following paragraphs.

Local participation

Local participation is the most influential risk mitigation factor in international construction project success criteria with a path coefficient of 0.97. This group consists of the following variables: (1) establishing a joint venture with local partners, (2) good relationships with local government and power groups and (3) offering local employment. Because these variables are directly related to interactions with local participants from the host country, it is named local participation.

Similar to other developing nations, the construction firms from India are expanding rapidly in the international market and it requires familiarity with the host country's business practices, legal and political system, industry structure and culture. This can be achieved by active partaking from the local players. This finding is in line with the study carried out by Lee *et al.* (2011) and Deng *et al.* (2014) for Korean and Chinese construction companies, respectively. Through case studies, Mahalingam and Levitt (2007) also explain the importance of local participation in avoiding conflicts and enhancing project success in global projects. According to Han *et al.* (2007), the degree of localization is a critical criterion for project profitability in the international arena. From the above, it can be recognized that, for developing countries, the influence of local participation plays a major role in achieving project success criteria at the international level.

In local participation, establishing a JV with local partners is an important risk mitigation measure with a path coefficient of 0.86. For firms from developing countries, the local partner support is advantageous in international market access, resource sourcing, risk sharing and sometimes to satisfy the host government policies. For example, Lee *et al.* (2011) describe the success of Samsung Industrial Company in obtaining the order and successful completion of the construction of Burj Khalifa in Dubai. They attribute this success primarily to their consortium with Arabtec, a local construction company that could mobilize and source the required materials and workforce. Wang *et al.* (2004) also strongly recommend the JV type vehicle as an effective risk mitigation measure while executing projects in the international market by Chinese construction firms. In addition to risk mitigation, JV can also create new business opportunities (Goh and Loosemore 2017). To achieve higher project success criteria and to mitigate future risks, it is essential to select the right JV partner, draft a fair agreement and establish an appropriate working structure to mitigate future risks and achieve higher project performance (Bing *et al.* 1999).

In local participation, forming good relationships with local government and power groups is the second most important risk mitigation measure, with a path coefficient of 0.60. In most international construction projects, the host government is a principal client and can directly influence the project by introducing different rules and procedures (Deng *et al.* 2014). The host government is also one of the core causes of political risks (Al-Khattab *et al.* 2007). Therefore, instituting a long-term association with the host government can be an effective risk mitigation strategy against political risks. Similarly, relations with governments and local power groups (e.g. business associations, labour union and so forth) can effectively tackle the political and social environment in which the international firm operates.

Offering local employment is another risk mitigation measure in this factor with a path coefficient of 0.59. Local employees often have more related working experiences and know more about local regulations than those directly employed by the main contractor. Local employees can also communicate effectively with their compatriot supervisors. Gao *et al.* (2016) endorsed the use of local employment as an effective method of managing risks in international projects. However, in some regions, such as the Gulf countries, the availability of a workforce is a big concern (Al-Sabah *et al.* 2014). Thus, an adequate pre-project survey of local employment availability is recommended to avoid cost escalation and interruption to progress in international construction projects. Sometimes international firms tend to use a workforce from the host country or low-wage developing countries, which are familiar with local working conditions (Mahalingam and Levitt 2007).

Contract selection

Contract selection is the second most influential risk mitigation factor, with a path coefficient of 0.90. This group consists of the following variables: (1) selecting an efficient sub-contractor (path coefficient 0.84), and (2) selecting a suitable contract (path coefficient 0.50). As these variables are related to contracts and their choice, this factor is named contract selection.

Within the contract selection group, choosing an efficient sub-contractor to execute the project is an important risk mitigation measure with a path coefficient of 0.84. Subcontractor selection is crucial for an international construction project's success criteria, as they physically execute almost all the key activities in construction projects. Sometimes, expert/specific agencies are required to perform specialized work at the international level. In addition, firms tend to transfer project risk through subcontracting. Thus, efficient sub-contractor selection plays a vital role in project success criteria, especially at the international level. Various past studies (Akintoye and MacLeod 1997, Lee *et al.* 2018) support the necessity of a capable subcontractor to meet the project success criteria. For firms from developing countries, it is recommended to follow the structured three-stage process of subcontractor selection for international construction projects, as suggested by Ulubeyli *et al.* (2017). The three-stage process in sub-contractor selection includes: (1) shortlisting based on experience, formal relationship, personal relationship, workload, reputation, litigation history, past performance, financial strength, the location of the home office and safety standard (2) negotiation based on the level of communication, reliability, problem-solving ability, knowledge of the project, selfless attitude, enthusiasm for the project, and quality awareness (3) final selection based on a payment plan, quoted price, and resource deployment.

Selecting a suitable engineering contract is another risk mitigation measure in this group, with a path coefficient of 0.50. This implies that the clarity and completeness of the contract documentation before a project starts are critical for project success criteria (Ozorhon *et al.* 2006). A good engineering contract must contain clear project definitions, legal terms, specifications, design instructions and implementation processes. Also, contract conditions, such as a reimbursement clause, adjustment clause, time extension clause, and variation clause, are essential in international projects. It is expedient to convince a client to implement recent international contract conditions, such as the World Bank procurement contracts or International Federation of Consulting Engineers, which are familiar to most of the international construction firms (Hastak and Shaked 2000).

Pre-project planning

Pre-project planning is the third most influential risk mitigation factor, with a path coefficient of 0.82. This group consists of variables such as: (1) carry out a proper feasibility study, (2) allocate contingencies, (3) insure everything that is insurable and (4) keep proper financial options. Since these variables are related to planning related activities before the commencement of an international construction project, the name is pre-project planning.

Pre-project planning is the process by which the project participants develop adequate preparation to address probable risks and to maximize the chance for a successful project (Gibson *et al.* 1995). Unlike firms from developed countries, developing countries possess less experience in the international market. So, to meet project success criteria, it is essential to carry out feasibility studies along with alternate arrangements, such as insurance, and contingencies to meet the uncertainties during project execution. The findings of Deng *et al.* (2014) and Gad *et al.* (2013) also highlight the importance of pre-project planning for international projects to meet the project success criteria and avoid potential risks including political risks.

Amongst pre-project planning, carrying out a proper feasibility study emerged as the most important risk mitigation measure with a path coefficient of 0.78. Accurate feasibility studies during the early stages of a project are crucial for the project's success criteria. The surveys conducted by Yildiz *et al.* (2014) and Zhang (2011) also stress the need for an adequate feasibility study to overcome various risks during project bidding and execution phases. Bing *et al.* (1999) propose to conduct a thorough feasibility study to guarantee a workable international construction project.

Allocating adequate contingencies during the estimation stage has emerged as a second important risk mitigation measure in this group with a path coefficient of 0.77. Though adding a contingency can offset project risks, firms are less likely to win a contract, if the contingency is set too high. Low contingency could also result in significant financial losses. Therefore, firms must be wise enough to foresee the risk that will occur, identify their potential financial impact and then determine the contingency. As per the research carried out by Kadry *et al.* (2017), the reliable estimation of contingency can result in overcoming project delays and, subsequently, lead to project success in global projects. The studies by Diab *et al.* (2017), Smith and Bohn (1999) and Hammad *et al.* (2016) can be referred to for optimum contingency estimation in construction projects.

Insuring everything that is insurable in the international arena is the third important risk mitigation measure in this group, with a path coefficient of 0.76. In a few countries, an international investment insurance system is provided by the government of the exporting country to guarantee or ensure foreign investors who may encounter different risks. The various past studies (Zhi 1995, Al-Sabah *et al.* 2014) conclude that insuring everything that is insurable is an effective channel for risk response in international construction projects.

Keeping proper financial options to overcome the various risks is another risk mitigation in this group, with a path coefficient of 0.60. Economic and financial risks can be reasonably predicted by gathering information from embassies, economic magazines, banks, newspapers and experts' risk judgment. Obtaining a host government's guarantee of foreign currency convertibility and remittance, purchasing financial instruments, such as option contracts, forward and future contracts, or currency swaps, fixed interest loans and escalation clauses in the contract are some of the options to overcome financial and economic risk.

Conclusion

As firms become international, they are exposed to new risks. The success of construction firms carrying out international projects significantly depends on how the risks that stem from the host country conditions are managed. Throughout the project life, risk management necessitates an emphasis on appropriate risk mitigation measures. This study attempts to identify a set of prime important risk mitigation measures that influence an international construction project's success criteria. From the literature survey, nine risk mitigation measures were identified and, using factor analysis, they were grouped into three risk mitigation factors, namely (1) local participation, (2) contract selection and (3) pre-project planning. Furthermore, the causal relationship between the risk mitigation factors and project success criteria were modelled with the help of SEM. The output of the SEM supports the hypothesized positive relationship between risk mitigation factors and project success criteria for an international construction project with a strong path coefficient of 0.80 at the 0.05 significance level.

The SEM model revealed that local participation is the most critical risk mitigation factor, with a path coefficient of 0.97, followed by contract selection (path coefficient of 0.90) and pre-project planning (path coefficient of 0.87). These risk mitigation factors have a direct influence on project success criteria in international construction projects, such as cost performance (path coefficient of 0.77), schedule performance (path coefficient of 0.68) and firm's performance (path coefficient of 0.62). Adoption of these risk mitigation measures will positively influence the success criteria of international construction projects. From these results, it is found that for developing countries like India, local participation from the host country plays a crucial role in achieving project success criteria at the international level.

By investigating the influence of various risk mitigation measures on project success criteria, this research contributes to the relevant body of knowledge relating to international project risk management by generating a model that will enable construction firms from India and similar developing countries to focus on a few risk mitigation measures to minimize the risks associated with international construction projects. The insights offered in this research can be useful information for aspiring international marketers, practitioners and medium and small-scale firms.

This study is limited to the data and survey results obtained from Indian construction firms, mainly from contractors and consultants. Though similar neighbouring and developing countries can use the model identified in this study, the results cannot be directly used in developed countries without adequate substantiation. The responses are also heavily skewed towards projects from the Asian and African regions. As the number of international projects is comparatively high in these regions for emerging markets like India, the outcome of this study cannot be used directly for other regions. Sometimes while executing international projects, international construction projects can be greatly influenced by the nature of the project. So, it is recommended to extend this research to different kinds of projects. Even though much care was taken in selecting the respondents, common shortcomings observed in the questionnaire survey, such as differences in understanding and a deficiency of conscientious responses, were not uncommon in this study. Further research is recommended to expand the knowledge of the effect of risk mitigation measures on different project phases and categories.

Data availability

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Disclosure statement

No potential conflict of interest was reported by the authors.

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