The dependence upon context of project critical success factors: test of the contingency hypothesis and effects of technological uncertainty and collectivism culture

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## Abstract

Although the relationship between critical success factors (*CSF*s) and project performance is established, evidence regarding the dependence on the context of *CSF*s is patchy. To advance this field, we conduct two complementary studies. Study 1 examines contingency theory regarding managerial *CSF*s using survey responses (*N* = 211) of project management professionals from the United Kingdom. Using survey data from projects (*N* = 336) in the United Kingdom, Study 2 examines the contextual dependence of managerial *CSF*s in a moderated-moderation, theoretical framework whereby project technological uncertainty moderates the relationship between managerial *CSF*s and project execution and efficiency, and in-group collectivism culture of the executing organisation moderates the effect of technological uncertainty. Results confirm that external and internal contexts influence managerial *CSF*s. Managerial *CSF*s have a greater than expected influence on project execution and efficiency. The positive effect of managerial *CSF*s is weaker when technological uncertainty is high. When technological uncertainty is high, the effect of managerial *CSF*s strengthens as levels of in-group collectivism culture increase. However, when technological uncertainty is low, the effect of managerial *CSF*s weakens as levels of in-group collectivism culture increase. We discuss the managerial and theoretical implications.

## Keywords

Project failure; Project execution and efficiency; Managerial critical success factors; Project technological uncertainty; In-group collectivism culture; Contingency theory.

**1. Introduction**

A major strand of research into the root causes of project failure focuses on describing, understanding and evaluating critical success factors (*CSFs*). Invariably, *CSF*s literature reviews (see, e.g., Belassi and Tukel 1996; Fortune and White 2006; Hughes et al. 2016) manage to identify numerous qualifying studies. Similarly, the significant effect of *CSFs* on project performance is one of the oldest and most robust findings in the project management literature (e.g., Pinto and Prescott 1988; Pinto and Mantel 1990; Brown and Jones 1998; Fortune and White 2006; Hughes et al. 2016; Jun, Qiuzhen, and Qingguo 2011; Pinto and Slevin 1987; Morris and Hough 1987).

To date, though, only limited studies have empirically addressed the dependence upon *CSFs* context: Jun, Qiuzhen, and Qingguo (2011) examined the moderating effects of generalised project uncertainty and Pinto and colleagues (Pinto and Mantel 1990; Pinto and Prescott 1988) assessed dependence upon the project lifecycle. Literature suggests that projects are sensitive to a range of contexts; these include the political, economic and socio-cultural (Galilea and Medda 2010; Jugdev and Muller 2005; Osei-Kyei and Chan 2015), the technological (Shenhar and Dvir 1996; Henderson and Stackman 2010; Tatikonda and Rosenthal 2000), the environmental (Fernández-Sánchez and Rodríguez-López 2010; Vifell and Soneryd 2012) and the legal (e.g., Ismail 2013; Chou et al. 2016). Consequently, although existing studies of the context-dependent nature of *CSF*s reveal valuable insights, they only address a small subset of the foregoing contextual factors that projects face. This leaves a critical gap in our understanding of how well (or poorly) critical success factors work in many of these important contexts. To advance the field, we examine the dependence of critical success factors upon two of the most important contexts the literature has yet to address: *technological uncertainty* (Baccarini 1996; Geraldi and Adlbrecht 2007; Williams 1999) and *collectivism organisational culture* (e.g. Kirkman, Lowe, and Gibson 2006; Tsui, Nifadkar, and Ou 2007).

We frame the problem from the viewpoint of the *executing organisation*, which is the ‘parent’ organisation responsible for planning and executing the project. In the main, we refer to project-based firms (Whitley 2006), that is those Winch (2014, p. 724) characterised as "project suppliers", whose core business and primary operations are projects. We develop the construct of *managerial CSF*s, which delineates those *CSF*s – wholly or substantially – within the control of the executing organisation. In other words, we regard managerial *CSF*s as a function of the executing organisation. Study 1 examines the extent to which contexts, both internal and external to the executing organisation, may influence managerial *CSFs*. Study 2 expands on the general findings of study 1 by testing the expected positive relationship between managerial *CSFs* and project *execution and efficiency,* which we define as a performance dimension based on how well the executing organisation executes the project process, and the extent to which they achieve this within budgetary and time constraints. Second, it tests a moderated-moderation model whereby technological uncertainty within the project and the in-group collectivism culture of the executing organisation moderate the influence of managerial *CSFs* on project performance.

Thus, the paper addresses four specific research objectives. One: It empirically tests contingency theory regarding managerial *CSFs*. Two: it reaffirms and estimates the strength of the expected positive relationship between managerial *CSFs* and project execution and efficiency. Three: it examines how technological uncertainty may moderate how strongly managerial *CSFs* relate to project execution and efficiency. Four: it examines the extent to which in-group collectivist organisational culture may temper the moderating effects of technological uncertainty.

Results indicate support for our propositions. Therefore, the paper offers several theoretical and practical contributions. The main theoretical contribution is that we integrate several strands of literature to formulate a theoretical model, which regards the project and the parent organisation as interacting, but discrete, entities. We then empirically test the transboundary, moderated-moderation effects between the temporary organisation – that is, the project – and the relatively enduring characteristics of its parent organisation. Our key practical contribution is guidance on how project-based firms may adapt in the face of high project technological uncertainty to assure the effectiveness of managerial *CFSs*. One suggestion is that perhaps they could adopt strategies that foster high levels of in-group collectivism organisational culture.

The rest of the paper proceeds as follows. The next section reviews the literature on the key concepts and constructs of the topic. The third section overviews the research approach and describes the procedures, data, analysis and results from the two studies. The next section synthesises and contextualises the main findings and explains the paper’s contributions to theory and practice. Finally, limitations and directions for future research are discussed.

## 2. Literature

We constructed this paper from several bodies of literature and their intersections. First, we defined managerial critical success factors and then explored the contingency upon context and effects of managerial critical success factors based upon the *CFSs*, contingency theory and project performance literature. We then built a moderated-moderation theoretical framework based upon evidence from the project technological uncertainty, the impermanence of projects as organisations, and organisation culture literature.

### Managerial Critical Success Factors

#### A typology of Managerial Critical Success Factors

Critical success factors (*CSFs*) are considered factors that determine project success. The notion of *CSFs* is a general one and has been applied to whole organisations (Rockart 1978), as well as in other operations management areas – for example, supply chain management (Denolf et al. 2015; Luthra, Garg, and Haleem 2015) and manufacturing practices (Haleem et al. 2012). A long-standing body of research into *CSFs* in projects has produced a large variety of *CSFs* that differ in nomenclature, if not in concept. (For fuller reviews, see: Belassi and Tukel 1996; Fortune and White 2006; Hughes et al. 2016). This plethora of *CSFs* can cause variable selection problems for *CSFs*-based predictive modelling; however, typologising offers a potential solution. As Doty and Glick (1994) argued, typologies are a useful way to build theory. In our research context, typologies can help us construe meaningful constructs from the many possible *CSFs*. Belassi and Tukel’s (1996) framework provides one such typology. They categorise critical success factors as those related to the project manager, the project team, the project, the organisation and the external environment.

Building upon Belassi and Tukel’s (1996) framework, we propose a more aggregate typology whereby critical success factors diverge into *managerial* and *non-managerial* *CSFs*. We define *managerial CSFs* as those that the executing organisation can manage or, at least, influence to a meaningful degree *as an integral part of project management.* Hence,factors such as organisational culture which involves long-term processes outside the realms of the project are *non-managerial* *CSFs*. In our typology, thus, we classify as *managerial* those factors that, according to (Belassi and Tukel 1996), are related to the project manager, the project team and the executing organisation. Conversely, we classify as *non-managerial* the factors that, according to Belassi and Tukel, are related to the project and the external environment

Examples of factors in the literature relating to executing organisation-relevant *CSFs* include *top management support* (e.g., Cleland and King 1983; Morris and Hough 1987); *resource provision* (e.g., Morris and Hough 1987; Belassi and Tukel 1996); *project champion, mission, goals and sponsorship* (e.g., Pinto and Prescott 1988; Cooke-Davies 2002); and *project structure, infrastructure, power and politics* (Morris and Hough 1987; Pinto and Slevin 1987). Factors pertinent to the project manager include *planning, estimating, piloting*, and *requirements* and *scope management* (e.g, Baker, Murphy, and Fisher 1983; Cleland and King 1983); *control*, *review* and *monitoring* (e.g, Pinto and Mantel 1990; Belassi and Tukel 1996; Dvir et al. 1998) and *scheduling* (e.g, Cleland and King 1983; Morris and Hough 1987). Project team-related examples are *competencies*, *skills* and *knowledge* (e.g, Kealey et al. 2006; Baker, Murphy, and Fisher 1983); *communication* (e.g, Cleland and King 1983; Pinto and Mantel 1990); *trouble shooting* and *feedback* (e.g., Pinto and Slevin 1987; Dvir et al. 1998); and *commitment* (e.g, Hughes et al. 2016).

Here, rather than modelling the *CSFs* as individual, independent variables, as most studies do, we adopt the systemic approach suggested first by Pinto and Slevin (1987) and later by Hughes et al. (2016). We model managerial *CSFs* as a higher-level construct comprising a system of distinct but interdependent factors that the executing organisation can collectively deploy. We argue that this is the appropriate approach, given how highly correlated *CSFs* are (Hughes et al. 2016; Pinto and Slevin 1987; Dvir et al. 1998; Fortune and White 2006). Further, our rationale for using a *managerial* *CSFs* construct is that it allows us to examine how such a construct might interact with other contextual, non-managerial factors. Consequently, we should be able to offer guidance to practitioners on how they may attempt to employ managerial *CSFs* to adapt to specific contexts. Since the defining characteristic of managerial *CSFs* is manageability from the executing organisation’s viewpoint, any such guidance should be actionable.

#### Contingency hypothesis of Managerial Critical Success factors

The fundamental premise of contingency theory is that, to optimise performance, organisations must adapt their structures to fit varying contexts (Donaldson 2001). The evaluation of project performance through the lens of contingency theory is patchier and more nascent than elsewhere in operations management (see Howell, Windahl, and Seidel 2010, for a review of the project contingency literature). Notable examples include studies that favour the contingency paradigm over the ‘one size fits all’ approach (Geraldi, Maylor, and Williams 2011; Shenhar 2001; Williams 2005) and studies that account for contextual contingency when evaluating performance (Muller, Geraldi, and Turner 2012; Zwikael and Ahn 2011). We follow the latter approach by conducting research into the contingency of *CSFs*.

Research suggests that the relative importance and significance of distinct types of *CSF*s change with the circumstances of the project; i.e. *CSF*s are dependent upon contingent factors. Important contingent factors include project uncertainty (Jun, Qiuzhen, and Qingguo 2011; Shenhar 2001), the political, social and cultural environments (Kealey et al. 2006; Simkhovych 2009; Dale and Dulaimi 2016), and the project lifecycle stage (Pinto and Mantel 1990; Pinto and Prescott 1988). This suggests that contingency theory should hold with respect to managerial *CSF*s. If, as contingency theory suggests, contexts affect organisations to the extent that they must respond accordingly, and if, as we have argued, managerial *CSF*s are a function of the executing organisation, then they too are contingent upon context. Hence, our first set of hypotheses considered whether contingency theory generally holds with respect to managerial *CSF*s:

***H1a****: Managerial CSFs depend upon external context; and*

***H1b****: Managerial CSFs depend upon internal context.*

#### Influence of Managerial CSFs on project execution and efficiency

The proposition that one needs multiple dimensions to fully evaluate project performance is now widely accepted. This is because different evaluative measures fit different circumstances. For example, to account for dynamics, some measures may be appropriate at different stages in the project lifecycle while others may be appropriate to account for different stakeholders’ interests, among other factors. Consequently, a range of project performance measures exist in the literature (see Chipulu et al. 2014; Högl and Gemünden 2001; Muller, Geraldi, and Turner 2012; Pinto and Mantel 1990; Shenhar et al. 2002; Tukel and Rom 2001). Given this multiplicity of potentially relevant measures, there is no definitive answer as to what constitutes project success or failure. As such, we argue that it is important to define precisely how performance is measured when studying the effects of *CSFs* on performance.

Our paper focuses on *project execution and efficiency*, which is a measure of performance based on how well the executing organisation implements the project process and the extent to which they do so within budgetary and time constraints. There are two reasons for this choice. First, to control for the variance of the effect of *CSFs* across the lifecycle (Pinto and Prescott 1988), we consider only project performance at the implementation stage or thereafter because that is when it becomes possible to evaluate project execution and efficiency. Second, there is no evidence yet to support the hypothesis that *CSFs* universally affect all aspects of project performance: Although we acknowledge the intrinsic value of investigating the influencers of project performance beyond execution and efficiency, it is beyond the scope of this paper.

As stated above, the positive influence of *CSFs* on project performance is one of the oldest and most robust findings in the literature (e.g., Pinto and Prescott 1988; Pinto and Mantel 1990; Brown and Jones 1998; Fortune and White 2006; Hughes et al. 2016; Jun, Qiuzhen, and Qingguo 2011; Pinto and Slevin 1987; Morris and Hough 1987). Therefore, to confirm the expected relationship between managerial *CSFs* and project execution and efficiency, we test the following hypothesis:

***H2****: Managerial CSFs positively relate to project execution and efficiency.*

### Technological Uncertainty as Moderator

By definition, projects are ‘unique’ endeavours (PMI 2013). Therefore, projects are characterised by uncertainty (Zwikael and Ahn 2011) as uniqueness makes it impossible to fully understand or predict all elements relevant to decision making (Gifford, Bobbitt, and Slocum 1979). Research shows that uncertainty can be a significant moderator of a range of relationships in organisational and operations management settings (e.g., Cannella, Park, and Lee 2008; Dayan, Ozer, and Almazrouei 2016; Wang, Yeung, and Zhang 2011). From their review of the project contingency literature Howell et al. (2010) inferred that uncertainty is the most dominant contingency factor in project management. Meanwhile, Jun, Qiuzhen, and Qingguo (2011) found that project uncertainty may moderate the effects of project planning and control on the process performance. This general evidence, which validates the notion of uncertainty as a contingent environmental variable, leads us to consider the more specific mechanism where the level of technological uncertainty moderates the relationship between managerial *CSFs* and project execution and efficiency.

*Technological uncertainty* arises when organisations adopt or develop unfamiliar technologies (Burkhardt and Brass 1990). It is widely recognised as a major issue, particularly in the complexity of projects’ literature (Baccarini 1996; Geraldi and Adlbrecht 2007; Williams 1999). Shenhar and Dvir (1996) argued that technological uncertainty is one of only two fundamental characteristics for classifying projects. Even so, much of the empirical research into the effects of technology uncertainty has focused on new product development projects (see Tatikonda and Rosenthal 2000), leaving a relative gap in our understanding of the impact of technological uncertainty beyond new product development projects. Thus, this paper extends the analysis by positing that technological uncertainty may attenuate how managerial *CSFs* relate to the execution and efficiency of *any* project where technology is used.

In projects, high technological uncertainty can be characterised by use of technologies that are novel or even non-existent at project inception (Shenhar 2001; Tatikonda and Rosenthal 2000). Under these conditions, uncertainty may arise from both epistemic and stochastic processes (Hoffman and Hammonds 1994), both internally within the executing organisation and externally. Events may be unpredictable, information may be unavailable or inconsistent, and individuals may feel uncertain about what they know or what is generally known (Brashers 2001). Thus, technological uncertainty may indirectly affect the efficacy of estimation, planning and scheduling *CSFs* (e.g, Herroelen and Leus 2005; Jun, Qiuzhen, and Qingguo 2011). Uncertainty may also affect clarity of the project objectives, goals or mission (see Ward and Chapman 2003).

Technological uncertainty may also have other, less obvious, indirect effects. Novelty (Tatikonda and Rosenthal 2000; Shenhar 2001) and lack of experience (Maylor, Vidgen, and Carver 2008) can increase task complexity (Campbell 1988). Therefore, it may be more difficult to achieve project tasks under high technological uncertainty, thereby rendering project manager- and team-related *CSFs* less impactful. Similarly, lack of information causes the brain to view choices under high uncertainty as likely to lead to unknown, perhaps even dangerous, outcomes (Hsu et al. 2005). Consequently, decision performance may diminish under conditions of high technological uncertainty as individuals search for additional information to reduce uncertainty. Although a possible consequence of this delay may be improved communication, under conditions of time and resource constraints, such as those in projects, groups may take short-cuts to reduce uncertainty (Kramer 1999), thus distorting normal communication channels (Srinivasan, Mukherjee, and Gaur 2011). As such, communication effectiveness may suffer rather than improve. High technological uncertainty may also be problematic for project control mechanisms where the project team predicate their behaviour on the information available to them (see Lenfle and Loch 2010).

Consequently, considering these arguments, we tested the following hypothesis:

***H3****: Higher technological uncertainty within the project correlates with a weakening of the positive relationship between managerial CSFs and project execution and efficiency.*

###  Executing Organisation’s In-group Collectivism Culture of as “Cushion”

Projects are also characterised by impermanence and, consequently, are often modelled as temporary organisations (e.g., Sydow, Lindkvist, and DeFillippi 2004; Bakker 2010). However, Winch (2014) rejected this characterisation and instead argued that projects should be defined as *determinate* organisations in that they have an agreed upon end date; this distinguishes projects from going concerns, whose end date is *in*determinate. Whichever designation one favours, projects do not exist in a vacuum; rather, they are an entity in an eco-system (Grabher 2002). In one ecosystem, the project exists within a ‘parent’ organisation, which is responsible for organising and executing the project (Grabher 2002; Engwall and Jerbrant 2003). Whilst there has been much work on projects as temporary organisations (Bakker 2010; Packendorff 1995), there is a relative gap in our understanding of how the project as a temporary organisation interacts with the permanent elements in the ecosystem (Winch 2014; Grabher 2002). Engwall and Jerbrant (2003) argued that the analysis of project performance should extend to transboundary interactions between the project and its 'parent' organisation.

 One of the most important transboundary interactions occurs between the project and the organisational culture of its parent organisation. There is a strong body of literature on the effects of organisation culture in project management. (For a fuller review on cultural perspectives in project management, see: Ojiako et al. 2012; Chipulu et al. 2016). However, studies tend to be imprecise about the organisational boundaries that the cultural effects traverse. For example, Gu et al. (2014) did not specify whether the organisational culture they study refers to that of the project, its parent or both. This is a limitation. We argue that we can better understand how the two entities might interact by explicitly specifying the project and parent organisation as interacting, but discrete, entities. As such, we can examine how instrumental the enduring characteristics of the parent organisation, such as its organisational culture, may be for managing the more transitory, within-project, effects that begin and cease with the project. (Jacobsson, Burström, and Wilson 2013) suggested this conceptualisation we are not aware of an empirical study that has applied it in this setting.

Thus, based upon Hsee and Weber’s (1999) *cushion hypothesis*, we posit that an extant in-group organisational culture can temper the potential attenuating effects on managerial *CSFs* of *high* technological uncertainty, whilst having the converse effect of enhancing the attenuating effects of *low* technological uncertainty. We have chosen in-group collectivism because, with many significant effects reported in the management literature (Tsui, Nifadkar, and Ou 2007), it is undoubtedly an important contextual variable whose influence is likely to extend to project performance.

Culture is often loosely defined as representing ‘shared characteristics’ (e.g. Erez and Earley 1993, , p. 41) such as basic axioms (Leung et al. 2002), values and practices (Hofstede 1980; House et al. 2004). We can model culture at multiple, nested levels (e.g. Erez and Gati 2004) including the individual, organisational, national and global. Commonly, management studies focus on national-level cultural differences. However, substantive questions remain about the validity of national cultural differences given within-country heterogeneity (Sivakumar and Nakata 2001). Hence, this paper considers culture at the *organisational* level. Further, we argue that, from the perspective of assessing how environmental variables may or may not enhance the effectiveness of managerial *CSFs*, it is more beneficial to study culture at the organisational level rather than the national level because it may be possible for organisations to foster cultural practices that support organisational goals in the long term (Schein 2010).

Schein (2010) defined organisational culture as the characteristic behaviour of members of the same organisation arising from their shared values and beliefs. Cultural immersiontheory (House et al. 2004) suggests that a culture develops as individuals in an organisation increasingly share schemas or scripts (Erez and Earley 1993) for interpreting and responding to stimuli. Meanwhile, gradually, organisational culture becomes more definitive as the concentration of individuals with shared characteristics grows. According to Schneider, Goldstein, and Smith (1995) *Attraction-Selection-Attrition* (ASA) model, individuals are attracted to organisations that they believe fit them and organisations select individuals they think fit them. Over time, as those who do not fit in leave, the organisation becomes more homogeneous, acquiring a stronger culture. Firms that employ ‘project organising’ as the primary means of operations, such as construction firms and engineering consultants, are also particularly likely to develop cultures by enculturation under the conditions specified by theory Z (Wilkins and Ouchi 1983).

Perhaps, collectivism is the most widely researched dimension of organisational culture (e.g. Kirkman, Lowe, and Gibson 2006; Tsui, Nifadkar, and Ou 2007). Building upon earlier work by Hofstede (1980), House et al. (2004, p. 12) defined *in-group collectivism* as how members of a society ‘express pride, loyalty, and cohesiveness in their organizations or families’. Evidence (e.g., Shane 1995; Gibson 1999; Kirkman, Lowe, and Gibson 2006) suggests that collectivism significantly moderates the effects of a number of organisational behaviours. We argue that these effects of collectivism may generalise and propose that in-group collectivism may moderate how technological uncertainty moderates the effects of managerial *CSFs* following a U-shaped pattern.

 Evidence suggests that people tend to take riskier decisions in collectivist cultures than in individualistic ones (Weber and Hsee 2000). To account for these differences, Hsee and Weber (1999) proposed the *cushion hypothesis* whereby members of collectivist cultures are emboldened to take riskier decisions because the existence of a supportive social network acts as insurance against catastrophic results. We argue that the cushion effect may help project practitioners overcome the state of limbo arising from technological uncertainty. In this case, given the presence of a supportive network should outcomes be unfavourable, practitioners in a collectivist organisational environment will experience more freedom to act at times of high technological uncertainty than they would in a less collectivist environment. In effect, we argue that a positivist collectivism organisational culture can act as a form of *‘cognitive’ social capital* (Nahapiet and Ghoshal 1998, , p. 244), which organisations can tap into at times of high technological uncertainty. Thus, we hypothesise:

***H4a****: When technological uncertainty within the project is high, higher levels of in-group collectivism culture in the executing organisation correlate with a stronger positive relationship between managerial CSFs and project execution and efficiency.*

On the other hand, when technological uncertainty is low, practitioners should be freer to take calculated decisions. As such, bolder, riskier action, as suggested by the cushion hypothesis, may be counter-productive. Furthermore, according to Wilkins and Ouchi (1983), a strong clan mentality may hinder rather than enhance transactions under conditions of low technological uncertainty. This suggests the opposite of the cushion effect when technological uncertainty is low:

***H4b****: When technological uncertainty within the project is low, higher levels of in-group collectivism culture in the executing organisation correlate with a weaker positive relationship between managerial CSFs and project execution and efficiency.*

## 3. Data, Methods, Analysis and Results

### 3.1 Overview of Research Approach

We conducted two complementary studies. Figure 1 is a pictorial representation of the two studies.

Study 1 aimed to determine whether contingency theory, generally, holds with respect to managerial *CSFs*. It tested the hypotheses that managerial *CSFs* depend upon external (*H1a*) and internal context (*H1b*).

Study 2 elaborated on and illustrated the general findings of study 1 by examining the contingency of managerial *CSFs* upon specific contexts. It examined the effect of managerial *CSFs* on project execution and performance (*H2*); whether that effect is moderated by technological uncertainty within the project (*H3*); and whether the effect of technological uncertainty is itself moderated by the executing organisation’s in-group collectivism culture (*H4a* and *H4b*).



**Figure 1**: Overall Model

### Study 1: An empirical test of the contingency hypothesis of Managerial Critical Success factors

#### Survey Procedure and Data

We gathered data from project professionals based in the United Kingdom from within our own (i.e. the authors’) professional networks. Via an email link, we asked each respondent to complete the survey and then circulate it to professionals based in the UK within their own network. Thus, we executed a non-random, snowball sampling approach, which is suitable in this situation where there is not a known sampling frame of project professionals (see, e.g., Chipulu et al. 2014).

We began the survey by defining managerial *CSFs*, using the same definition as the one we have provided in this paper. Then, we asked respondents to estimate, on a scale of 1 = ‘not all’ to 5 = ‘a very large amount’, the influence on the effectiveness of *managerial CSFs* on project performance of (i) external and (ii) internal environments outside/within the project’s *executing organisation* as defined in this paper.

We collected 211 valid responses. There were slightly more women (55%) than men (45%). The average age was 28.6 (*SD* = 9): 19% of the respondents described their typical role in projects as *Project Manager*; 14% as *Project Director or other senior project role*; 18% as *End user, Sponsor or Client;* and 49% as *Other* roles.

#### Analysis and Results

We analysed the survey data with hierarchical log-linear modelling as the variables of interest are categorical comprising count data. We ran two models to analyse responses about external contexts and about internal contexts, respectively. Although log-linear models do not have dependent variables, we set measures of the perceived influence of internal and external contexts as the ‘dependent’ variables for the two models as they are our target variables, whose variance we would like to explain. To avoid extremely low frequency counts, we concatenated the categories ‘not at all’ and ‘a small amount’. We included gender, age and project role in the models to control for demographics, which may influence individual perceptions of the importance of different factors on project performance (see, e.g., Ojiako et al. 2015) . Since age is a continuous variable, we recoded its values into categories of ‘younger’ and ‘older’ for below and above the mean age, respectively.

**Table 1**: Log-linear model results – influence of internal and external contexts

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | External Environment | Internal Environment |
| *Model Fit (Likelihood Ratio Chi-Square)* |  | 16.1 (p = 0.764) | 7.1 (p = 0.982) |
| *Exponentiated Main Effect Estimates for 'dependent'* | *Not at all or a small Amount* | 0.95 (p = 0.7686) | 1 (p = 0.9969) |
| *A fair amount* | 1.21 (p = 0.2012) | 1.43 (p = 0.004) |
| *A large amount* | 1.27 (p = 0.1022) | 1.62 (p = <.0001) |
| *A very large amount* | 0.69 (p = 0.0588) | 0.5 (p = 0.0007) |
| *Two-way Interaction Effects of 'dependent' with demographics (Chi-square)* | *Gender* | 3.76 (p = 0.2888) | 5.74 (p = 0.1248) |
| *Role* | 12.2 (p = 0.2022) | 4.31 (p = 0.89) |
| *Age Group* | 1.73 (p = 0.6293) | 2.09 (p = 0.5541) |

Allowing for all two-way interactions in the log-linear models for both external and internal contexts was sufficient to obtain a good fit. Table 1 shows the results, which include the model fit summaries, the main effects, and the interaction effects of the ‘dependent’ variables with demographic variables.

The results support both *H1a* and *H1b*. A significant majority of respondents believe contexts influence managerial *CSFs* by at least ‘a fair amount’. They view internal contexts as being more influential than external ones; the significant effect was that 162% more of the respondents than would be expected under the null hypothesis of equality stated the influence of internal contexts to be a 'large amount'. Thus, there is stronger support for *H1a* than for *H1b*. It is notable, however, that the influences of the internal and external contexts are not thought to have a ‘very large’ large influence, with the proportion of professionals who chose that level significantly lower than would have been expected under the null of hypothesis of equality. There is no significant variance in the perceived effects of contexts on managerial *CSFs* due to gender, age or role in projects, which indicates consensus among a range of project professionals.

### Study 2: A moderated-moderation model of Managerial Critical Success Factors

#### Measures and Survey data

We based all our scales on existing, validated measures.

To measure project execution and efficiency, we adapted six items from the literature, each measured on a seven-point Likert-type scale (1 = very strongly disagree to 7 = very strongly agree). The items were (i) ‘The project was within budget’; (ii) ‘The project was within schedule’ (e.g. Rubin and Seeling 1967); (iii) ‘The project management process was satisfactory’ (e.g., Pinto and Mantel 1990) ; (iv) ‘From our organisation's perspective, the project progressed well’ (e.g., Högl and Gemünden 2001); (v) ‘Project risk management was satisfactory’ and (iv) ‘The agreed project scope was achieved’ (e.g., Chipulu et al. 2014).

We integrated evidence from several studies to derive a managerial *CSFs* scale. As we discussed earlier, many measures can constitute a managerial *CSFs* construct. To ensure scale completeness, we began by identifying at least one measure each for factors related to the project manager, team and organisations. To ensure non-overlapping measures, based on conceptual clarity and distinctiveness, we then reduced the number to five widely cited measures (see, Fortune and White 2006) developed by Pinto and Prescott (1988), which empirical evidence suggests have the most substantial impact on project success (Zwikael and Globerson 2006). Using a seven-point Likert-type scale (1 =‘very weak’ to 7 = ‘very strong’), the items were (i) ‘Communication: The provision of an appropriate network and necessary data to all key actors in the project implementation’; (ii) ‘Top Management Support: Willingness of top management to provide the necessary resources and authority /power for project success’; (iii) ‘Project Mission: Initial clearly defined goals and general directions’; (iv) ‘Personnel: Recruitment, selection, and training of the necessary personnel for the project team; and (v) ‘Project Schedule/Plan: A detailed specification of the individual action steps for project implementation’.

To measure in-group collectivism cultural practices, we used the scale developed by Project GLOBE (House et al. 2004). Using seven-point Likert-type scale items, with bespoke categories, the scale comprises five items: (i) ‘In this organisation, group members take pride in the individual accomplishments of their group manager’; (ii) ‘In this organisation, group managers take pride in the individual accomplishments of group members’; (iii) ‘In this organisation, employees feel loyalty to the organisation’; (iv) ‘Members of this organisation take no pride in working for the organisation’; and (v) ‘This organisation shows loyalty towards employees’.

Typically, researchers measure level of technological uncertainty based on how familiar a particular technology is to the organisation (see, e.g., Tatikonda and Rosenthal 2000). We used a binary scale adapted from the typology developed by Shenhar (2001). The categories were:

* ‘Low’: The project relied only on well-established technologies or the project relied mainly on well-established technologies plus some new technologies; and
* ‘High’: Most of the technologies used in the project were new when the project started or the project required the use of technologies that had not yet been developed when it started.

We then gathered survey data using these measures. Since our theoretical model requires 16 individual survey items, we estimated the minimum required sample as *N* = 160 using the “10 cases per variable” rule of thumb (e.g., Peduzzi et al. 1995). However, we set the target sample size as twice this minimum – i.e. *N* = 320 – to allow flexibility. Eight project researchers collected data by sampling from practitioners located in the UK (*UK*) from within their own professional networks on *LinkedIn* following the same protocol. Sampling was an iterative process, where samples were systematically taken at intervals of around two months as follows: Each researcher randomly selected 50 professionals from their own *LinkedIn* network filtered by the “United Kingdom” location and the “project management” keywords. Next, they emailed the selected professionals to request their participation in the survey. Then we inspected the quantity and quality of new returns and, if the total number of valid returns did not exceed the target sample, we repeated the process with each researcher re-sampling without replacement from their professional network.

For this research, we considered a response invalid for any of the following reasons:

* Participant did not have experience of a recent project, which was organised and executed by *their* organisation;
* The main project activities were conducted outside the *UK*;
* Participant failed to provide the correct response to an attention-check question buried within the survey;
* Participant completed questionnaire too quickly, i.e. in under 5 minutes; the expected duration was 10 minutes; or
* Participant did not supply responses on key variables, e.g., technological uncertainty.

We began the survey by asking respondents to appraise a recent project conducted by their organisation. To minimise the effect of project lifecycle (Pinto and Prescott 1988), respondents appraised projection execution and efficiency at the implementation stage or later. Subsequently, respondents appraised in-group collectivism cultural practices within their organisation.

We present more details on the characteristics of the sample in Table 2.

**Table 2:** Characteristics of Sampled Projects

*a. Industry Sectors and Technological Uncertainty:*

|  |  |  |  |
| --- | --- | --- | --- |
| *Industry Sector (UK SIC 2007)* | Low' Tech  | High' Tech | Total |
| *Services* | 58 | 10 | 68 (20.61%) |
| *Software* | 40 | 10 | 50 (15.15%) |
| *Construction* | 31 | 5 | 36 (10.91%) |
| *Retail Trade* | 24 | 4 | 28 (8.48%) |
| *Manufacturing* | 21 | 13 | 34 (10.3%) |
| *Wholesale Trade* | 13 | 1 | 14 (4.24%) |
| *Financial* | 13 | 7 | 20 (6.06%) |
| *Media Publishing* | 10 | 3 | 13 (3.94%) |
| *Agriculture, Forestry And Fishing* | 8 | 0 | 8 (2.42%) |
| *Education* | 7 | 0 | 7 (2.12%) |
| *Mining/Extraction* | 6 | 2 | 8 (2.42%) |
| *Property/Real Estate* | 5 | 0 | 5 (1.52%) |
| *Transportation and Communication, Electric, Gas and Sanitary Services* | 5 | 3 | 8 (2.42%) |
| *Healthcare* | 2 | 0 | 2 (0.61%) |
| *Other* | 22 | 7 | 29 (8.79%) |
| *Total* | 265 (80.3%) | 65 (19.7%) | 330(100) |
| Frequency Missing (Industry Sector) = 6 |  |  |  |

*b. Project Size: Number of Organisations and People:*

|  |  |
| --- | --- |
| *Number of Organisations* | Number of People |
| Frequency  | Less than 10 | At least 10 but less than 50 | At least 50 but less than 100 | At least 100 | Total |
| *One* | 71 | 31 | 5 | 2 | 109 (32.44%) |
| *Two* | 46 | 34 | 5 | 2 | 87 (25.89%) |
| *Three to five* | 26 | 53 | 10 | 8 | 97 (28.87%) |
| *More than five* | 7 | 10 | 8 | 18 | 43 (12.8%) |
| *Total* | 150 (44.64%) | 128 (38.1%) | 28 (8.33%) | 30 (8.93%) | 336 (100%) |

*c. Project Budget and Duration:*

|  |  |
| --- | --- |
| *Project Budget (USD*) | Project Duration |
| Frequency  | Less than a year | 1-2 years | 3 to 5 years | Longer than 5 years | Total |
| *Less than $500k*  | 132 | 59 | 11 | 4 | 206 (61.31%) |
| *At least $500k but less than $5m*  | 28 | 45 | 11 | 3 | 87 (25.89%) |
| *At least $5m but less than $100m*  | 3 | 13 | 9 | 1 | 26 (7.74%) |
| *At least $100m*  | 2 | 5 | 3 | 7 | 17 (5.06%) |
| *Total* | 165 (49.11%) | 122 (36.31%) | 34 (10.12%) | 15 (4.46%) | 336 (100%) |

Overall, we collected data on 336 projects. Respondents described the level of technological uncertainty as ‘low’ in 271 (81%) projects and ‘high’ in 65 (19%) projects. The projects originated from a wide range of industries. With χ2 = 21.70 (df = 14, p = 0.085), the Chi-Square test of independence suggests the distribution of technological uncertainty is independent of industry sector. Typically, the projects involved up to five organisations, up to 50 people and a budget of up to $500k (USD), and were completed within two years. [To clarify: To help the reader to contextualize size in monetary terms outside of the *UK*, we asked respondents to estimate budget amounts in terms of the United States Dollar (USD), which is much more globally recognized rather than the *UK* Pound Sterling.]

#### Latent Scale Evaluation

We began by evaluating the factorial validity of the execution and efficiency, in-group collectivism and managerial *CSFs* scales. We subjected the scores on the items on each scale to confirmatory factor analysis (*CFA*). The Chi-Square values of 23.6 (*DF* = 9, *p* = 0.005), 8.6 (*DF* = 2, *p* = 0.014) and 15.5 (*DF* = 5, *p* = 0.008) for execution and efficiency, in-group collectivism and managerial *CSFs*, respectively, were significant. However, the Root Mean Square Error of Approximation (*RMSEA)* values of 0.048, 0.057 and 0.046 and the Comparative Fit Index (*CFI)* values of 0.978, 0.978, 0.973 for execution and efficiency, in-group collectivism and managerial *CSFs*, respectively, all indicate very good fit for the data. Similarly, all items had significant positive loadings greater than 0.5 on their designated factors and all Average Variance Explained (*AVE)* values were greater than 0.5 for all scales. This suggests that the latent scales have convergent validity.

By calculating covariance among the latent scales, we were able to compare each latent scale’s AVE against its correlation with the other two scales. In all cases, as Table 3 shows, each scale’s AVE is greater than its correlation with the other two scales. This indicates that the scales have discriminant validity. Consequently, we can conclude that the *CFA* models confirm the factor structures of the three scales.

**Table 3**: Comparison of Latent Scales AVE values against Correlation Coefficients

|  |  |  |  |
| --- | --- | --- | --- |
|  | *Execution* | *MCSF* | *Culture* |
| *Execution* | **0.726** |  |  |
| *MCSF* | 0.609 | **0.630** |  |
| *Culture* | 0.475 | 0.43 | **0.628** |
| AVE values in bold type |

Next, we examined the internal consistence of the scales. All three scales showed good internal consistency, yielding acceptable Cronbach’s alpha values (*N* = 336) of 0.91, 0.78 and 0.88for execution and efficiency, managerial *CSFs,* and in-group collectivism, respectively.

Finally, we examined common method bias (*CMB*). First, we created a baseline structural equation model with the three scales as correlated factors. We then added an unmeasured latent common factor to all the indicators of the three scales, constraining as equal all the regression paths to the latent factor. Comparison of the baseline and latent factor model fits showed a non-significant change (Δ*CFI* = 0.00). In contrast, the Harman one-factor test produced a significantly poorer fit (Δ*CFI* = - 0.128), with the single factor only explaining 33% of the variance. Based on these results, and given that the complexity of our hypothesised relationships is unlikely to be part of respondents’ *theory-in-use* (Harrison, McLaughlin, and Coalter 1996), we were reassured that *CMB* is not likely to be a significant issue.

#### Analysis and Results

We began with a base model comprising a covariance-based Structural Equation Modelling (SEM) in Amos 25, which specified *Execution and Efficiency* as the dependent and *Managerial* *CSF*s as the predictor. The base model was a good fit for the data with *RMR* = 0.169, *RMSEA* = 0.029, *CFI* = 0.962 and *NFI* = 0.922. Table 4 shows the estimated standardised effects, which were all significant with p-values smaller than 0.001. The regression coefficient of +0.7 indicates that managerial CSFs significantly influences Execution and Efficiency.

**Table 4**: Estimated Standardised Effects-based SEM model

|  |  |  |  |
| --- | --- | --- | --- |
| **Indicator** |  | **Factor** | **Estimated Effect** |
| ***Execution*** | <--- | *MCSF* | 0.739 |
| ***Process*** | <--- | *Execution* | 0.913 |
| ***Progress*** | <--- | *Execution* | 0.808 |
| ***Risk Management*** | <--- | *Execution* | 0.842 |
| ***Scope*** | <--- | *Execution* | 0.849 |
| ***Schedule*** | <--- | *Execution* | 0.837 |
| ***Budget*** | <--- | *Execution* | 0.86 |
| ***Mission*** | <--- | *MCSF* | 0.778 |
| ***Top Management Support*** | <--- | *MCSF* | 0.775 |
| ***Planning*** | <--- | *MCSF* | 0.836 |
| ***Personnel*** | <--- | *MCSF* | 0.745 |
| ***Communication*** | <--- | *MCSF* | 0.83 |

To examine the moderating effect of technological uncertainty on the relationship between managerial *CSF*s and Execution and Efficiency, we extended the model to run multigroup SEM with technological uncertainty as the grouping variable. The unconstrained model was a good fit for the data with *RMR* = 0.175, *RMSEA* = 0.057, *CFI* = 0.951 and *NFI* = 0.911. Although both were highly significant (p-value < 0.001), the regression path coefficients of the effect of Managerial *CSF*s on Execution and Efficiency differed between the two groups: the coefficient for low technological uncertainty environments was +0.72, whereas for high technological uncertainty it was substantially smaller at +0.43.

Next, we constrained the regression path coefficient of the effect of Managerial *CSF*s on Execution and Efficiency, specifying equality between the low and high technological uncertainty groups. The change in the model Chi-square between the constrained and unconstrained models was significant [Δ*χ2* = 3.90*, DF* = 1, *p-value* = 0.048]. This indicates that technological uncertainty moderates the effect of Managerial *CSF*s on Execution and Efficiency: the effect of Managerial *CSF*s on Execution and Efficiency is stronger in low technology uncertainty environments than it is in high technological uncertainty environments.

However, we did not have a large enough sample of the high technological uncertainty subgroup (*N* = 65) to run an identified structural equation model testing the full moderated-moderation model with the latent constructs. Therefore, to reduce the number of parameter estimates, we summated the items on each scale by averaging. The mean values were 3.23 (*SD* = 1.53) for execution and efficiency, 3.26 (*SD* = 1.10) for managerial *CSFs* and 2.79 (*SD* = 1.24) for in-group collectivism, which suggests that typical values are low (< 3.5), particularly on in-group collectivism. Using the summated scales, we then tested the full moderated-moderation model using Hayes’ (Hayes 2013) process procedure in SPSS 23, setting execution and efficiency (Execution) as *Y*, managerial *CSFs* (*MCSF*) as *X*, technological uncertainty (Uncertainty) as *M,* and in-group collectivism as *W*. The model was a good fit for the data; it accounted for 46.7% of the variance, with *F* (7, 336) = 204.4, *p* < 0.00011.

Table 5 shows the estimated effects. Consistent with hypothesis 2, the effect of managerial *CSFs* on execution and efficiency is positive and significant. The +0.65 regression coefficient suggests that changing managerial *CSFs* by 1% predicts 0.65% change in project execution and efficiency. This estimated effect is of similar magnitude to the SEM model estimate above. Both suggest that managerial *CSFs* have a substantial effect on execution and efficiency.

**Table 5:** Estimated effects of explanatory and moderator variables

*a. Model Parameter Estimates:*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *coeff* | *se* | *T* | *p* | *LLCI* | *ULCI* |
| *Constant* | 3.2337 | 0.0438 | 73.7905 | 0.0000 | 3.1477 | 3.3196 |
| *Uncertainty* | -0.0315 | 0.1074 | -0.2936 | 0.7693 | -0.2423 | 0.1793 |
| *MCSF* | 0.6491 | 0.045 | 14.4261 | 0.0000 | 0.5608 | 0.7374 |
| *MCSF\*Uncertainty* | -0.2357 | 0.116 | -2.032 | 0.0430 | -0.4634 | -0.0081 |
| *Culture* | 0.3042 | 0.0488 | 6.2302 | 0.0000 | 0.2084 | 0.4001 |
| *MCSF\*Culture* | 0.0004 | 0.0217 | 0.0202 | 0.9839 | -0.0422 | 0.043 |
| *Uncertainty\*Culture* | 0.3085 | 0.1344 | 2.2965 | 0.0223 | 0.0449 | 0.5722 |
| *MCSF\*Uncertainty\*Culture* | 0.0517 | 0.0649 | 0.7965 | 0.4263 | -0.0756 | 0.179 |

*b. Conditional effect of MCSF on Execution at values of the moderators:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Culture* | *Uncertainty* | *Effect* | *se* | *t* | *p* | *LLCI* | *ULCI* |
| -1.0972 | -0.2203 | 0.7130 | 0.0640 | 11.1342 | 0.0000 | 0.5874 | 0.8387 |
| -1.0972 | 0.7797 | 0.4206 | 0.1478 | 2.8467 | 0.0047 | 0.1307 | 0.7106 |
| 0.0000 | -0.2203 | 0.7010 | 0.0495 | 14.1576 | 0.0000 | 0.6039 | 0.7982 |
| 0.0000 | 0.7797 | 0.4653 | 0.1049 | 4.4356 | 0.0000 | 0.2595 | 0.6712 |
| 1.0972 | -0.2203 | 0.6890 | 0.0442 | 15.5957 | 0.0000 | 0.6023 | 0.7757 |
| 1.0972 | 0.7797 | 0.5100 | 0.0957 | 5.3277 | 0.0000 | 0.3222 | 0.6979 |
| *Values for quantitative moderators are the mean and plus/minus one SD from mean.* |
| *Values for dichotomous moderators are the two values of the moderator.* |

*c. Conditional effect of MCSF on Execution at values of the moderators:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Culture* | *Effect* | *se* | *t* | *p* | *LLCI* | *ULCI* |  |
| -1.0972 | -0.2924 | 0.1610 | -1.8158 | 0.0703 | -0.6084 | 0.0236 |  |
| 0.0000 | -0.2357 | 0.1160 | -2.0320 | 0.0429 | -0.4634 | -0.0081 |  |
| 1.0972 | -0.1790 | 0.1054 | -1.6979 | 0.0905 | -0.3859 | 0.0279 |  |

The main effect of in-group collectivism organisational culture is positive and significant, whereas the main effect of technological uncertainty is not significant. The interactions of *MCSF*\*Uncertainty and Uncertainty\*Culture are significant at the 0.05 p-value level, but no other interactions are significant.

Examination of the conditional effects suggests that *strength* of the effect of managerial *CSFs* on execution and efficiency varies with technological uncertainty and in-group collectivism: Slope changes occur even though the sign of the slope remains positive. For all levels of in-group collectivism culture, the effect of managerial *CSFs* on efficiency and execution is weaker when technological uncertainty is high, confirming findings from the SEM modelling, and indicating support for hypothesis 3.

When technological uncertainty is high, the effect of managerial *CSFs* on execution and efficiency strengthens as levels of in-group collectivism culture increase. By contrast, when technological uncertainty is low, the effect of managerial *CSFs* on execution and efficiency weakens as levels of in-group collectivism culture increase. A comparison of the simple slopes shows that the increase in the slope between low and high levels of in-group collectivism when technological uncertainty is high is +0.09; whereas the increase between high and low levels of in-group collectivism when technological uncertain is low is much smaller at +0.02. Consequently, although three-way interaction is non-significant, these simple slope results appear to support both hypotheses 4a and 4b, with the evidence in support of hypothesis 4a being stronger.

## 4. Discussion and Conclusion

### 4.1 Research Findings

Our results confirm the expected positive relationship between managerial *CSFs* and project execution and efficiency. The estimated effect suggests that changing managerial *CSFs* by 1% predicts over 0.6% of the change in project execution and efficiency. This is a substantial effect. It is greater than the effects reported for individual *CSFs* in prior research such as, for example, Pinto and Mantel (1990). Since *CSFs* significantly correlate, the substantial regression coefficient may indicate that, jointly, the *CSFs* have a greater, possibly synergistic, effect than individual *CSFs* have. Had we followed the lead of previous research and considered *CSFs* as discrete and independent effects, we would not have been able to observe how much more influential *CSFs* may be when considered jointly.

Our findings from study 1 confirm the general hypothesis that the effectiveness of *CSFs* is contingent upon the context. It is likely that the contextual dependence of *CSFs* generalises to internal and external contexts, although internal contexts are considered more influential.

More specifically, our findings from study 2 suggest that the effectiveness of managerial *CSFs* may be less effective when technological uncertainty is high than when it is low. This is finding is consistent with Jun et al. (2011), who found that the effect of project planning and control on the process performance is moderated by project uncertainty. Furthermore, the effect of technological uncertainty may itself be contingent upon the level of in-group collectivism organisational culture. Consistent with Hsee and Weber’s (1999) cushion hypothesis, when technological uncertainty is high, the effect of managerial *CSFs* on execution and efficiency strengthens as levels of in-group collectivism culture increase. Conversely, when technological uncertainty is low, the effect of managerial *CSFs* on execution and efficiency weakens as levels of in-group collectivism culture increase. However, the latter effect is marginal; much smaller than the former. There is asymmetry so that one can view the effect of collectivism on the effect of technological uncertainty as shaped like a ‘reverse-tick’ rather than a u-shape. Hence, the collectivism culture of the executing organisation will matter most when technological uncertainty is high.

### Managerial Implications

The fact that project execution and efficiency is significantly dependent on managerial *CSFs* while the effectiveness of managerial *CSFs* is contingent upon context suggests that, to assure the effectiveness of managerial *CSF*s, project-based firms should adapt how they manage projects to specific contexts. That is, organisations should adopt a contingent-theoretic approach (Geraldi, Maylor, and Williams 2011; Shenhar 2001; Williams 2005) by responding in ways that account for these contextual influences.

Our findings suggest several specific ways to differentiate the management of projects with high technological uncertainty from those with low technological uncertainty:

* ***Assign even higher priority to managerial CSFs:*** Executing organisations should anticipate that managerial *CSFs* might be less effective given high technological uncertainty; they should respond by placing even higher priority on ensuring that managerial critical success factors are effective.
* ***Reduce technological uncertainty:*** Executing organisations should attempt to reduce the level of technological uncertainty. One way is to increase the level of organisational knowledge regarding the unfamiliar technology internally through training or externally through recruitment or consulting, among other initiatives. Other options are to avoid unfamiliar technologies where familiar ones exist; or sidestep the uncertainty by contracting a third party who is more familiar with the technology.
* ***Mitigate the effects of technological uncertainty by providing a supportive culture:***

Fostering a culture of in-group collectivism practices may help organisations mitigate the effects of high technological uncertainty. This is because, as we argued above, the supportive network provided by a collectivism culture will embolden practitioners to act even though uncertainty is high.

Building a distinctive organisational culture is necessarily a long-term process (Erez and Earley 1993; House et al. 2004; Schein 2010). Hence, the idea of building a collectivism culture that may cushion the negative effects of high technological uncertainty requires organisations to make a strategic choice to embed cultural practices that support operations. Specifically, project-based firms that rely on unfamiliar technologies – i.e. projects with high technological uncertainty – could make the strategic choice to foster in-group collectivism cultural practices, which may help mitigate the negative impacts of technological uncertainty on managerial *CSFs*.

Dynamic capabilities theory (Teece, Pisano, and Shuen 1997) explains how organisations can respond to sudden and unexpected technological changes. Dynamic capabilities differ from operational capabilities in that they are core competencies which organisations purposely develop in order to address rapidly changing environments (Helfat and Peteraf 2009). Meta-analysis indicates that dynamic capabilities consistently influence positive performance (Fainshmidt et al. 2016). High technological uncertainty is more likely when there is rapid technological change. Consequently, by suggesting a strategy of developing a collectivism culture as a cushion for high technological uncertainty, we imply that we should think of a collectivism culture as a dynamic capability, one that a firm can draw upon [even if inadvertently] in the face of rapid technological changes. This conception of culture as a dynamic capability is not new; it is consistent with previous research on organisational capabilities. For example, Chan, Shaffer, and Snape (2004) considered organisation culture as a dynamic resource; and culture is a constituent in Lawson’s model of innovation capability (Lawson and Samson 2001). Hence, our findings show the need for deeper enquiry into organisation culture among the elements considered in the (still) nascent research on project capabilities (Davies and Brady 2016).

In the short- to medium-term, results suggest that organisations should have a higher level of consciousness of the internal prevalent cultural practices so that they can determine how those practices may influence operations. For example, knowing that there is a low level of in-group collectivism cultural practices implies that critical success factors may not be as effective when such a firm is executing projects with high technological uncertainty. Thus, they could respond appropriately, for example, by trying to reduce the level of uncertainty or conferring higher priority to ensuring that managerial *CSFs* remain effective.

Specific uncertainties do not occur in isolation; rather, projects may experience multiple uncertainties from various sources simultaneously (e.g., Geraldi, Maylor, and Williams 2011; Williams 1999; Williams 2005). Consequently, our modelling of the effect of technological uncertainty as a discrete contextual influence is a simplification. However, Jun, Qiuzhen, and Qingguo (2011) finding regarding the moderating effects of (generalised) project uncertainty suggests that the presence of other types of uncertainty is unlikely to mitigate the effect of technological uncertainty. This is because the effect of any epistemic or stochastic uncertainties from other sources on managerial *CSFs* should work in the same way as we theorised for technological uncertainty in section 2.2. Consequently, we argue that our suggestions for addressing the effects of high technological uncertainty on managerial *CSFs* will remain valid even if uncertainties from other sources are high.

### Research Contributions

Our research makes two specific contributions to knowledge.

First, we advance knowledge on the contingency of critical successful factors upon context. We empirically show that managerial *CSFs* are viewed as contingent on both internal and external contexts. Further, drawing upon research on the impact of uncertainty, we develop, test and find support for hypotheses on the effect of technological uncertainty on the relationship between *CSFs* and performance. We then empirically test Hsee and Weber’s (1999) *cushion hypothesis* and find that in-group collectivism may cushion the negative effects of high technological uncertainty to some extent. To our knowledge, this is the first empirical test of such a theoretical model, which specifies the project organisation and parent organisation as discrete entities and then tests the transboundary effects between the temporary organisation – namely, the *project* – and the relatively enduring characteristics of its parent organisation.

 The second contribution regards how *CSFs* are conceptualised and modelled. Although the effect of critical success on project performance is well established, this is the first paper to examine the joint effect of critical success factors as a higher, aggregate, construct. The value of this approach, as we mentioned above, is our observation that *CSFs* may potentially be synergistic, so that their combined effect may be greater than previously thought.

### Limitations and Future Research Directions

An important limitation is that we were not able to estimate the full moderated-moderation model. As such the estimated effect of organisation collectivism culture is based on a summated scale as opposed to the latent scale of the construct. Therefore, future research can extend the robustness of the results by reaffirmation.

Second, we have framed the problem very narrowly from the viewpoint of one executing organisation. Our analysis does not extend to the more complex situations where several participating organisations share project execution, and may experience varying levels of technological uncertainty and organisational culture. Hence, a potential next step would be a model able to assess multiple executing organisations and interactions among them.

Finally, we have modelled the potential effects of technological uncertainty and in-group organisational culture in the *UK*. We would expect variance in the levels of both contexts across nations. For example, the prevalence of projects perceived to have high technological uncertainty may be higher in a country with lower technology development than the *UK*. Similarly, levels of in-group organisational culture may be significantly different, for example in Eastern Asian nations, due to the influence of national culture. Therefore, future research could examine the extent to which the contextual effects we have observed hold in projects conducted in other countries.

### Conclusion

Although project failure is a significant issue, there is relatively little research into how different contexts impact on the effectiveness of *CSFs*. We have discovered some of the ways that the effectiveness of *CSFs* can change with context. Therefore, managerial approaches to ensure that *CSFs* remain effective and, consequently, minimise the risk of project failure, should be contingent upon the context. Although we have examined the specific case of how managerial *CSFs* relate to project execution and efficiency, *CSFs* are a general concept, and many of the *CSFs* that are critical in project operations are critical in other forms of operations too. As such, besides project management, our results are important to operations in general: The effectiveness of factors that are critical to the success of operations is likely to also be contingent upon context.

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