

An operations readiness typology for mitigating against transitional 'disastrous openings' of airport infrastructure projects

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ABSTRACT

This paper seeks to highlight the essential readiness factors commonly engaged to prevent 'disastrous openings' of complex multi-stakeholder infrastructure projects. To identify these readiness factors, we undertook a survey of 724 Operations managers, Project managers and 'Operations Readiness, Activation and Transition' management practitioners working across four international airports in the United Arab Emirates. Data were analysed using SPSS/AMOS. What emerges from the data analysis is a risk-focused typology of knowledge that is able to prevent past mistakes from being repeated. The main contribution of the paper is twofold. *First*, the paper develops a risk-focused operations readiness typology. The *second*

contribution of the paper is the theorization of the risk-focused typology as abstract risk knowledge. Such knowledge, which emerges from risk forecasting serves to prevent past mistakes from being repeated. We recommend that future studies undertake further theoretical and empirical work on the significance of risk forecasting within the context of knowledge production.

Keywords: Operations; Readiness; Risk; ORAT

1. Introduction

1.1 *The prevalence of ‘disastrous openings’*

The prevalence of ‘*disastrous openings*’ (Brady and Davies 2010; p. 152) on the first day of commencement of operations of complex multi-stakeholder infrastructure projects has become very high profile. This is more so within global news on project risk management in infrastructure development¹ and on ‘Operations Readiness, Activation & Transition’ management (*hencewith*, ‘ORAT’). The general context of this paper is however that in the last three decades, the global demand for complex multi-stakeholder infrastructure projects has increased rapidly (Zeng et al. 2015). Of these arguably ‘mega’ projects, those focused on operationalizing infrastructure deemed vital for national development, have been fast-tracked towards commencement of operations. One example is Suvarnabhumi Airport in Thailand. The construction phase of the project commenced in 2002 to be completed in 2006 at an estimated cost of US\$3.8 billion. However, problems have beset the airport since it commenced operations (Croes 2007). In fact, these problems have persisted (Lefevre 2012; Jirapong et al. 2015) and are now often mentioned in both academic literature on operations readiness factors (see Steele-Johnson et al. 2010; Stevens 2013; Krauss 2014; Ventre et al. 2014; Artto et al. 2016; Chipulu et al. 2019) and more specifically, ORAT literature (Saounatsos 2009, 2010). The main message from the literature appears to be the enormous strain on both the risk management and management of ORAT associated with these projects. This message underlines the current study’s interest, which is directed towards enhancing isomorphic learning from previous project failures (see Williams 2008). Arguably, doing so will contribute to efforts to ensure that often glaring mistakes of the past are not repeated. The global stakes for getting this learning right are extremely high. Studies by Bhattacharyay and Biswa (2010)

¹ See, for example, Done, K. (2008), “*Heathrow Terminal 5 opening turns to farce*”, <https://www.ft.com/content/1ccdacd4-fc0f-11dc-9229-000077b07658>, accessed 05/12/18; Smith, O. (2018), “*Whatever happened to German efficiency? Berlin's new airport is a contender for the world's most useless*”, <https://www.telegraph.co.uk/travel/news/berlin-new-airport-delayed-again/>, accessed 05/12/18

estimate that the national investment needs for airport projects in Asia between 2010 and 2020 will be approximately US\$64.31 billion.

There is a long-standing legacy of very high profile and widely debated ‘*disastrous openings*’ which we can learn from. Examples include Denver Airport, Denver – the United States which commenced operations in 1994 with estimated cost of its ‘*disastrous openings*’ at US\$5 billion and Chek Lap Kok Airport – Hong Kong which commenced operations in 1998 with estimated cost of its ‘*disastrous openings*’ at US\$20 billion. Suvarnabhumi Airport, Bangkok – Thailand which commenced operations in 2006 with estimated cost of its ‘*disastrous openings*’ at US\$3.9 billion and Heathrow-Terminal 5, London – United Kingdom which commenced operations in 2008 with estimated cost of its ‘*disastrous openings*’ at US\$6.4 billion can also be added to this list.

It is important to acknowledge that not all of these ‘*disastrous openings*’ can be attributable to project *fast tracking*. In effect, the root causes of ‘*disastrous openings*’ can vary widely (Lee 2000; Davies et al. 2009; Brady and Davies 2010; Zerjav et al. 2018). Thus for example, the commencement of operations of London’s Heathrow Airport Terminal 5 experienced ‘*disastrous openings*’ even after 19 years of planning and construction (Brady and Davies 2010, p. 152). Hence to mitigate against these ‘*disastrous openings*’, there is a strong argument to focus not only on project risk management and ORAT management, but also on readiness factors. More specifically, project risk management and ORAT management will require the adoption of a risk forecasting philosophy that is not only construed as a risk knowledge production activity, but also balanced between abstract and concrete risk knowledge types. On the other hand, instead of readiness factors being defined in terms of root cause, it should be construed as abstract risk knowledge.

1.2 Aim of the study

Although acknowledging its importance (see Morris 1997; Brady and Davies 2010; Artto et al. 2016; Winch and Leiringer 2015), a recent review of the extant project management literature suggests little or no interest in examining the transitional phase from ‘project’ to ‘operations’ (see Locatelli et al. 2018). Consequently, there appears to be no widely agreed view on how a project should progress through any kind of structured management activity that ensures successful commencement of operations (Dvir 2005; Winch and Leiringer 2015; Locatelli et al. 2018). More recently, however, this position seems to be changing. Project management scholarship is now beginning to explore a much more forward-looking and more temporally extended view of what projects actually entail (Geraldini and Söderlund 2018). In fact, there have

been specific recent calls for ‘Project transition’ studies (see Locatelli et al. 2018). In effect, important steps towards recognizing the need for a dedicated operations phase within projects are being taken (Dvir 2005; Shokri et al. 2016). For example, frameworks now exist for operational preparations and readiness which have been adopted to ensure that projects are not only delivered, but also after delivery, that they operate successfully (see for example Durugbo and Riedel 2013). However we consider that an important challenge remains relating to the narrow use of these readiness frameworks; the reason being their use as performance frameworks instead of facilitators of seamless transition between what has been traditional distinct phases of projects and operations.

The aim of the present paper therefore is to examine the most commonly engaged readiness factors that may mitigate against disastrous commencement of operations immediately after successful project completion (delivery). To achieve this, we examine existing knowledge of/literature on readiness factors. What emerges is a four-factored risk-focused typology which will be theorized as abstract knowledge. We argue that this typology will guide the operations and project management community. For example, it will not only facilitate the abstraction of risk knowledge, but also provide the necessary guidance on how to manage risk both heading *towards* project completion and on *into* the first day of commencement of operations.

1.3 The research question

Some relevant literature (Artto et al. 2016) posits that the existence of a dynamic interface between two phases traditionally conceptualized as distinct; implies a need for management to focus on their *interdependencies*. Such managerial action, which we conceptualize in terms of *readiness*, is required because of the likely ineffectiveness of traditional project planning in highly dynamic project situations – for example, where project goals are likely to be changing (see Dvir and Lechler 2004). Evidence for this is provided by studies suggesting that unknown risk categories are particularly prevalent in complex projects (Ramasesh and Browning 2014; Maylor and Turner 2017; Williams 2017) and operations (Tucker 2004; Tucker and Spear 2006). It is within this context that we present our research question as follows:

RQ: What readiness factors are commonly engaged to prevent ‘disastrous openings’ at the transition between project completion and commencement of operations in complex multi-stakeholder settings?

2. Theoretical positioning

To further explain the present study in terms of abstract risk knowledge, the theoretical context for exploring the operationalization of complex multi-stakeholder projects is as follows. *First* are the complex multi-stakeholder infrastructure projects themselves; these are projects that deliver the primary facilities and supporting systems that serve national economic interests (Flyvbjerg 2009). Because of this role, they often encompass heterogeneous, contested and contradictory requirements and expectations (Flyvbjerg 2007). Often, these requirements come from multiple stakeholders, which may include not only civil society and the government but also customers and direct service users (Kennedy 2015). *Second* is that despite the volume of literature on project risk management (for recent reviews, see Williams 2017), the authors are not aware of any studies that merge the related themes of (i) risk intelligence-gathering within complex multi-stakeholder project contexts; (ii) optimization of risk categories for capturing and processing risk intelligence (bearing in mind multiple project stakeholder perspectives and intelligence sources); and (iii) risk knowledge production processes that take place within these contexts (bearing in mind practical issues of coordination and integration between multiple project stakeholders). Drawing these three themes together, with organizational rather than project risk management in mind, this present study adopts earlier assertions by Marshall et al. (2018a) who argue for a ‘*boosted risk radar*’ situated within an organization’s horizon scanning activities as part of its risk intelligence capabilities and risk knowledge production. Marshall et al. (2018a) suggested that risk forecasting as a form of knowledge production can be theorized as converting ‘*unknown-unknowns*’ into ‘*known-knowns*’ encapsulating two dimensions; ‘*abstract*’ and ‘*concrete*’ risk forecasting knowledge.

In an operations context, *readiness* has attracted a number of definitions, which attend only very obliquely to particular implications for risk management. Instead, the theme of change management is often salient. Thus, for example, readiness has been defined as “...*the cognitive precursor to the behaviours of either resistance to, or support for, a change effort*” (Armenakis et al. 1993, p.682). Weiner et al. (2008, p. 424) defined readiness as a “*two-dimensional construct that refers to organizational members’ motivation and capability to implement intentional organizational change*”, while Shokri et al. (2016) explored readiness from a combined manufacturing and psycho-cultural perspective. Drawing from Lee et al. (2011) and Antony (2014), they defined readiness as “*awareness of terminology, principle and benefits, eagerness to work in team projects and eagerness to work with data and statistics*”.

As a construct (Weiner et al. 2008, p. 424), from a risk management perspective, ‘*readiness*’ is clearly *forward-looking* (Armenakis et al. 1993; Shokri et al. 2016). We consider,

based on our earlier theoretical preliminaries, that readiness is always risk facing. Put more succinctly by Krauss (2014), “*Operational readiness, embedded in the project delivery process...becomes [is] a risk management activity*” (p.5). It always ‘*knows*’ some risk in the abstract through isomorphic learning and professional knowledge dissemination. It utilizes this knowledge to brace management to confront some area of risk where concrete manifestations of specific risk may or may not occur. In other words, it always addresses in abstract terms some risk context. This risk context may or may not prove relevant for dealing with as-yet ‘*unknown*’ risk within complex multi-stakeholder infrastructure projects. A specified area of ‘*operations readiness*’ is therefore always at the same time a ‘*risk category*’ which can be populated over the course of risk experience, with specific risks. From this stance, an operations readiness factor always attunes scanning for concrete risk information in order to address either some specified area of operations or operational transition.

3. Review of the literature

To be able to conceptualize ‘*operations readiness*’ as a key mitigator against ‘*disastrous openings*’, this study follows Krauss (2014) in utilizing the ‘*Broader conceptualization*’ (Pinto and Winch 2015; Svejvig and Andersen 2015; Geraldi and Söderlund 2018) category of the ‘*Rethinking project management*’ agenda (Winter et al. 2006). Accordingly, we explore ‘*operations readiness*’ as a construct that elucidates much broader requirements and knowledge than what may be conceptualized within traditional and more recognizable constructs such as ‘*commissioning*’ and ‘*change readiness*’.

3.1 Operations and change readiness

The ‘*operations readiness*’ construct is much broader than that of ‘*military readiness*’ (see Barzily et al. 1979; Horning et al. 2012). Traditionally, ‘*military readiness*’ has focused on “*the ability to provide and integrate capabilities required by combatant commanders to execute their assigned missions*” (United States Department of Defense 2011, p. 20). It entails ensuring that military personnel, equipment and support structures remain *ready* for immediate combat and operations deployment (Cosenzo et al. 2007; Horning et al. 2012). It is thus a much broader construct than ‘*commissioning*’ which is defined as a “*disciplined activity involving careful testing, calibration, and proving of all systems, software, and networks within the project boundary*” (Lawry and Pons 2013, p. 1). Dvir (2005) posits that ‘*commissioning*’ implies project handover to users.

Clearly, the emphasis of ‘*commissioning*’ on *preliminary* testing constitutes an

important means to develop concrete risk knowledge required for operations readiness and, hopefully, address unknown risk. However, this construction of ‘*commissioning*’ is inevitably limited in scope. Recent studies – for example, that of Brito et al. (2016) – have searched for transition mechanisms that are more effective than traditional ‘*commissioning*’ activities. Brito et al. (2016) recommend improvements, which they define in terms of ‘*operability*’; in effect, attainment of specified operational needs and requirements. Drawing from their work, the near equivalent construct used within the present paper will be ‘*operations readiness*’. This is defined by Wohl (1966, p.1) as the ability of “*multidevice, multimodal systems to meet specified operations requirements at any given time*”. Krauss (2014) had emphasized that operations readiness is a constituent element of project delivery. Our project application of the construct ‘*operations readiness*’ aligns with the broader operations readiness literature (Morris 1997; Dvir 2005; Krauss 2014; Hendershot 2015; Artto et al. 2016; Shokri et al. 2016). It does so through our applied definition of ‘*operations readiness*’ as

“...*the list of activities and plans, which can be considered enabling factors, and which should be planned for and executed by the project’s stakeholders to prepare for the successful transition from the project to operations stage of large infrastructure projects*”.

It must however be recognized that this definition and other understandings of ‘*operations readiness*’ are distinct from operations *reliability*. In particular, while *readiness* focuses on ensuring that systems are available (when needed) on the first day of operations, *reliability* focuses on ensuring that once the system becomes operational, it remains so (Mazumdar 1969). Reflecting on this distinction, we consider that ‘*operations readiness*’ cannot be approached as a multi-stakeholder risk management activity without taking into consideration ‘*operations reliability*’.

3.2 *Dynamic change interfaces*

Change management literature often considers ‘*readiness*’ a key factor in ensuring successful organizational change (Armenakis et al. 1993; Weiner et al. 2008; Rafferty et al. 2013; Stevens 2013). Following a review of this literature, it appears that the most important operative ingredient of this *readiness* construct is the existence of a proactive, dynamic and iterative process-driven set of evaluative actions and reactions (see Vakola 2013; Shokri *et al.* 2016).

Extending change management theories to the transition from project completion to operations commencement is definitely appealing. However, doing this this brings with it at least the following four problems. *Firstly*, the success criteria for such projects are contestable

(Cantarelli et al. 2010a, b; Williams 2016). These can only be established at the time the project output is being utilized; in other words, during its operational phase (Brady and Davies 2010; Arto et al. 2016). *Secondly*, as Stevens (2013) opines, the literature has tended to focus on readiness directed at specific change initiatives and not at readiness encompassing multidimensional situations. More fully, the problem here is that change is likely to occur at different times and across multiple aspects of organizational life. These are not easily captured, either in theory or in change management practice (Jian 2011). Hence, in complex multi-stakeholder infrastructure projects, the transition from project completion to commencement of operations should ideally entail dynamic and agile evaluations of a variety of delivery outcomes. *Thirdly*, there are possibilities of overlapping management categories and related practices. For example, one overlap relates to ‘*integrated project delivery*’ (El Asmar et al. 2013). This typically involves networks of customers, contractors, sub-contractors, suppliers and designers who are connected through strong inter-organizational relationships with the objective of enhancing project performance (Sariola and Martinsuo 2016). Another overlapping practice is ‘*benefits realization*’, which is well established in the information and technology project literature (Coombs 2015). However, because it is considered to occur towards the completion of the project phase, it has attracted limited attention in large infrastructure projects (Winch and Leiringer 2015). In defining benefit realization as “*the flows of value that arise from a project*”, Zwikael and Smyrk (2012, p. 11) had sought to link organizational performance to the successful realization of the implemented project. Thus, arguably, the benefits of the project will only be realized at the operational phase and not at the project phase. The *final* problem associated with extending change management theories to the transition from project completion to the commencement of operations relates to the representation of readiness as a continuous process (Stevens 2013). Notably, this process cannot be captured from any single narrow management standpoint. Complex multi-stakeholder infrastructure project delivery is associated with a number of unexpected and novel risks that require constant re-evaluation of its readiness. The view espoused by Stevens (2013) in particular, alerts us to the need for not only a dedicated risk management that flows seamlessly across projects and operations, but also for a common concern to develop a risk-focused typology that is able to anticipate challenges associated with the project-operations phase transition.

4. The study

Figure 1 (below) is a diagrammatical representation of the approach adopted in the study. This

approach is derived and adapted from Chipulu et al. (2019).

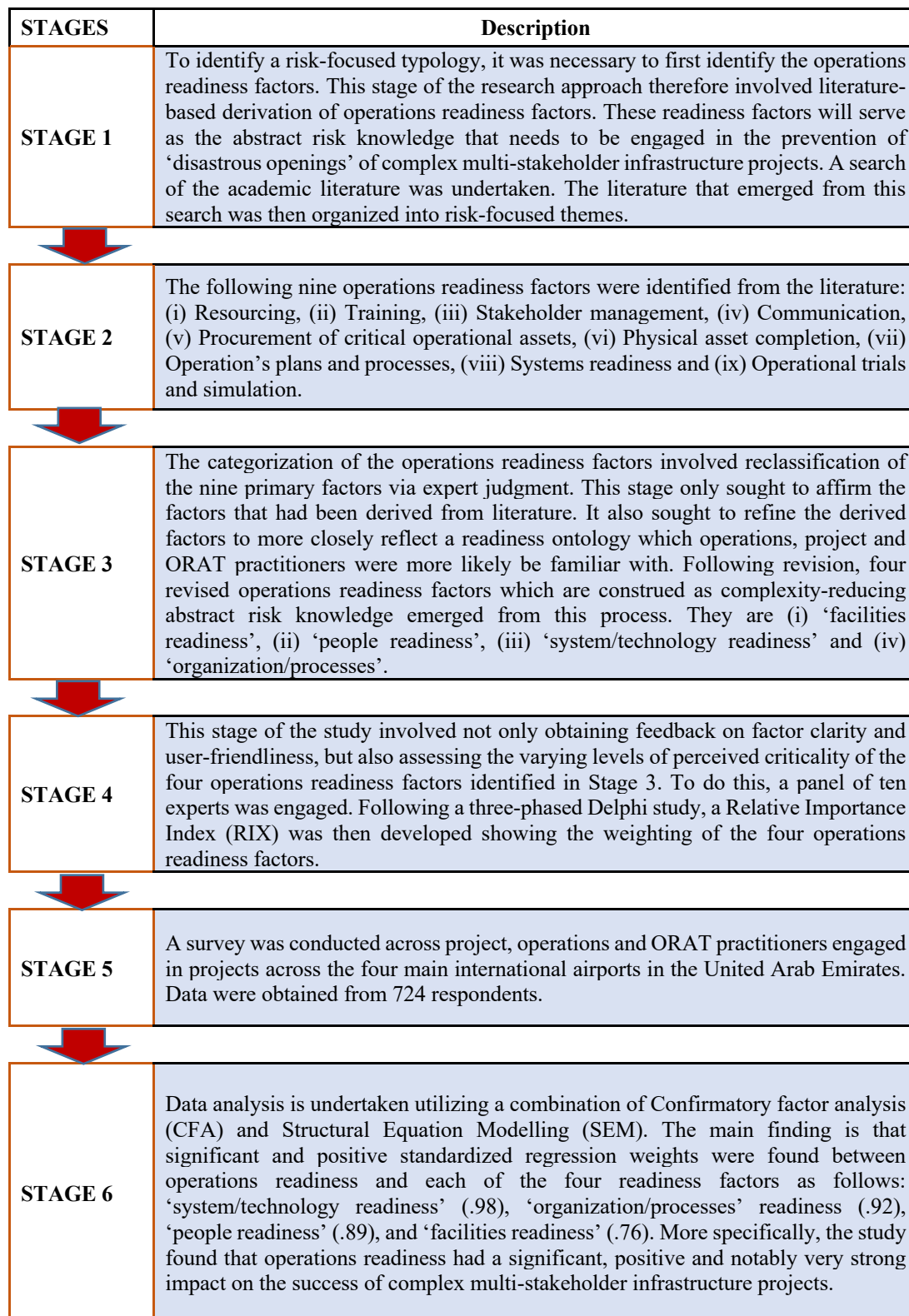


Figure 1. Diagrammatical representation of the research approach.

4.1 Stage 1 - Identifying the relevant literature

The literature emerged from initial searches of four databases – Web of Science, SCOPUS, JSTOR and EBSCO. Keyword searches were run against ‘*readiness*’, ‘*change readiness*’, ‘*operational readiness*’ and ‘*operations readiness*’. Duplicate publications from these searches were removed. The first and second authors then undertook a detailed review of the remaining publications. Further elimination was carried out of articles deemed not to focus on ‘*operational readiness*’ or ‘*operations readiness*’ (both terms had been used interchangeably). Another round of elimination followed whereby publications not deemed as relevant to project studies were eliminated. The outstanding articles were then organized into themes seen as able to provide a risk-focused typology for transition from project completion to the commencement of operations.

4.2 Stage 2 - Identifying the operations readiness factors

Stevens (2013) theorizes ‘*readiness*’ in terms of whether there are adequate resources (including human capital) for successfully driving change. While project management literature acknowledges the temporality of project teams (Prado and Sapsed 2016), it also recognizes that the hiring and training of qualified and able operations staff is vital for successful management of project interfaces (Morris 1997). For this reason, project-oriented organizations constantly face the difficult decision on whether to completely disband project teams at project termination, or maintain team integrity and exploit their boundary-spanning competencies and move them to other projects (Tukiainen and Granqvist 2016). Taking these strands of literature into consideration, this emergent operations readiness factor is termed ‘*Resourcing*’.

To ensure mission objectives are met with minimal risk of failure, there is a need to engage in readiness activities in the forms of both scenario training exercises (Trewin et al. 2010; Fletcher and Wind 2014; Harrison 2014) and post-engagement reviews (Fletcher and Wind 2014). Both initiatives – particularly training – can provide operations, project and ORAT practitioners with key knowledge, change adaptation and sense-making skills to cope with dynamic change interfaces (Steele-Johnson et al. 2010). However, for training to adequately support the sustaining and embedding of change emanating from readiness activities; it must be designed quite specifically to reshape core individual and organizational capabilities. ‘*Training*’ is hence construed as an emergent operations readiness factor.

Stakeholder theory supplies another popular basis for theorizing readiness factors.

Freeman (1984, p. 52), states that organizations “*must pay attention to any group or individual who can affect or is affected by the organization’s purpose, because that group may prevent [the firm’s] accomplishments*”. Yet doing so within large complex multi-stakeholder infrastructure projects is challenging for a number of reasons. *Firstly*, success is a multidimensional (Shenhar et al. 2001; Chipulu et al. 2014; Ojiako et al. 2014, 2015) and asymmetric construct (Mahring and Keil 2008; Bharadwaj et al. 2009; Chipulu et al. 2019). It draws upon numerous and differing assessment criteria at different points in the delivery lifecycle. *Secondly*, there is also stakeholder multiplicity to consider (Aaltonen and Kujala 2016; Davis 2017; Chipulu et al. 2019). Various stakeholders must all coordinate, and each of these co-ordinating entities has its own unique stakeholder contexts to consider. They also have contradictory individual institutional logics to contend with. This implies that stakeholders are likely to have differing priorities, interests and views of success. This will pose a number of major challenges for example relating to the question of how project priorities are set (Ojiako et al. 2015). Another challenge may touch upon how the existence of these different priorities limits meaningfully inter-stakeholder engagement (Chipulu et al. 2019). To further complicate matters, the complex nature of these transitions from project to operations can create opportunities for political and strategic manipulation as different operations, project and ORAT practitioners teams engage in opportunistic behaviour due to their conflicting self-interests (Jennings et al. 2018). Furthermore, with stakeholder multiplicity often come diverse reporting mechanisms and decision-making structures (Maylor and Turner 2017). To an extent, drawing on the words of Freeman (1984, p. 25) on the pragmatic need to take cognizance of all those who are able to impact or are impacted by the ‘*disastrous openings*’ of complex multi-stakeholder infrastructure projects, this emergent operations readiness factor is termed ‘*Stakeholder management*’.

Effective communication is a key risk mitigation factor in change readiness (Campbell et al. 2015). Communication among various stakeholders in complex projects has been strongly linked to project success (Ollus et al. 2011; Monteiro de Carvalho 2013). Armenakis et al. (1993) pointed out that because readiness initiatives must convince key stakeholders to change, there is a need to ensure that project communications is positively interpreted, and effective. This emergent operations readiness factor is named ‘*Communication*’.

Being operationally ready also entails ensuring that the entire series of activities and enabling factors that are associated with the wider contract strategy necessary to ensure the successful transition from the project to operations stage of large infrastructure projects is in place. Procurement will encompass acquisition and management of critical resources (De

Araújo et al. 2017). Procurement is widely recognized as a key source of risk project life cycles (see Tysseland 2008). A well-managed procurement strategy may benefit from readiness if the project team is well integrated. This in turn hinges on agreement and development of contract strategies, including strategies for risk management. In a recent study exploring factors likely to impede the success of mega-engineering projects, Aladağ and Işık (2018) found, amongst other factors, improper partner selection and incompetent contractor selection – in effect, procurement – as posing significant risks to the success of these projects. Thus, this emergent operations readiness factor is termed ‘*Procurement of critical operational assets*’.

Transiting from project to operations requires ensuring that the completed infrastructure is in a stable enough condition to be used. Harrison (2014) had considered the completion of the physical asset an essential element of readiness. There is a clear parallel here, which is useful for mutual learning purposes, with how the military uses simulations and warfare manoeuvres/gaming for readiness experimentation (Barzily et al. 1979). Extending this idea of experimentation and simulation to ensure readiness of physical assets, this operations readiness factor is termed ‘*Physical asset completion*’.

Some discussions of readiness processes and procedures have been available in project management literature for some time now (see Dvir 2005; Shokri et al. 2016). However, there is little or no literature on final asset operational plans and procedures within project management literature, even though the literature is now addressing extended project life cycles (Braglia and Frosolini 2014; Artto et al. 2016). The availability of final asset operational plans and procedures should support readiness in terms of, for example, progress monitoring. Lee (2000) cites disparities in the “attribution of responsibilities” (p. 62) – in effect, the complicated dynamics of decision making and monitoring of the project – as a major reason for the US\$20 billion ‘*disastrous opening*’ of Hong Kong’s Chek Lap Kok Airport. With this in mind, we identify ‘*Operation’s plans and processes*’ as an emergent operations readiness factor.

Viable and useable technology and systems are vital outcomes of any complex multi-stakeholder infrastructure operations (Gil et al. 2012). This is particularly important noting that, once assets become operational, any decision to enhance or improve what will be in effect a tightly coupled built-in technology will be restricted. Quilty (2003) observed that critical operational systems are sometimes not adequately tested before the commencement of operations. Best practice should emphasize the robust testing, validation and verification of technology and systems so as to provide assurance that they will be sustained once operations commences. However, this has not necessarily been the case. The US\$6.4 billion ‘*disastrous*

openings’ of Heathrow-Terminal 5 in London was attributable to a number of systems integration problems with its baggage handling system (Davies et al. 2009; Brady and Davies 2010). In terms of Hong Kong’s Chek Lap Kok Airport, failure was also attributed to the breakdown of the Flight Information Display System (FIDS) in the immediate aftermath of operations commencement (Lee 2000). This emergent operations readiness factor is termed ‘*System readiness*’.

Commissioning focuses on ensuring successful user handover following proving of functionality (Dvir 2005; Lawry and Pons 2013). To that end, complex multi-stakeholder infrastructure projects generally engage in ORAT – primarily operational trials and simulations involving the final staff (as recruited), as well as newly produced operational plans and procedures (Aladağ and Işık 2018). These trials are particularly useful for transfer of tacit knowledge and providing evidence of training effectiveness. They also offer rehearsal value by allowing facilities to be tested by final users in real scenarios before they face real customers (Ventre et al. 2014). We name this operations readiness factor ‘*Operational trials and simulation*’.

4.3 Stage 3 - Categorizations of the operations readiness factors

Following identification of the nine operations readiness factor as shown earlier (see Section 4.2), the next stage of the study involved their reclassification using expert judgment. As in the case of Chipulu et al. (2019), this step only seeks to firstly affirm the factors that had been derived from literature. Secondly, this step also seeks to refine the derived factors to more closely reflect a readiness ontology which operations, project and ORAT practitioners are more likely to be familiar with. To undertake this, an expert panel of four academics who were all experienced in use of assessment scales in projects was constituted. Furthermore, all four had considerable individual project management experience that was deemed comparable to the status of Chartered Engineer (CEng) or Chartered Project Professional (ChPP) and had served or were serving as external operations, project or ORAT consultants. This was particularly important, as they were able to draw on the critical understanding of the literature to provide key practitioner assessment of the face viability of the literature-derived factors.

Each panel member was required to indicate to what extent each of the nine operations readiness factors best aligned to the literature-designated operations readiness factors of ‘*people*’, ‘*processes*’, ‘*tools*’ (see Krauss 2014, p. 6) and ‘*system/technology*’ (Mankins 2009). Including ‘*system/technology*’ as a designated operations readiness factor (despite not having been identified by Krauss (2014)) was in response to infrastructure development literature,

which suggests that complex multi-stakeholder infrastructure projects are part of a wider network of technology systems (see Gil et al. 2012). Thus, for example, a high-speed railway project is part of a much wider integrated transportation system.

The process of *categorizations of the operations readiness factors* involved the expert panel generating and then assigning specific values to each derived operations readiness factor. The criterion for the assigning of the values was the extent of alignment as determined by the individual expert panel member. Responses were either ‘0’ = ‘does not match this factor at all’, ‘1’ = ‘to an extent matches this factor’ or 2 = ‘extremely matches this factor’. For each element, the scores of each panel member were summated across all the nine individual factors. As part of the process, where there was unanimous consensus on appropriateness, some of the elements were renamed for best fit. In sum, the four revised operations readiness elements that emerged from the study which are shown in Figure 2, below, are (i) ‘*facilities readiness*’, (ii) ‘*people readiness*’, (iii) ‘*system/technology readiness*’ and (iv) ‘*organization/processes*’. Noting the likely multi-level interaction between these factors (see for example, Rafferty et al. 2013), it is not expected that these factors will be equally influential as complexity-reducing abstract risk knowledge is likely to be commonly engaged to prevent ‘*disastrous openings*’ of complex multi-stakeholder infrastructure projects.

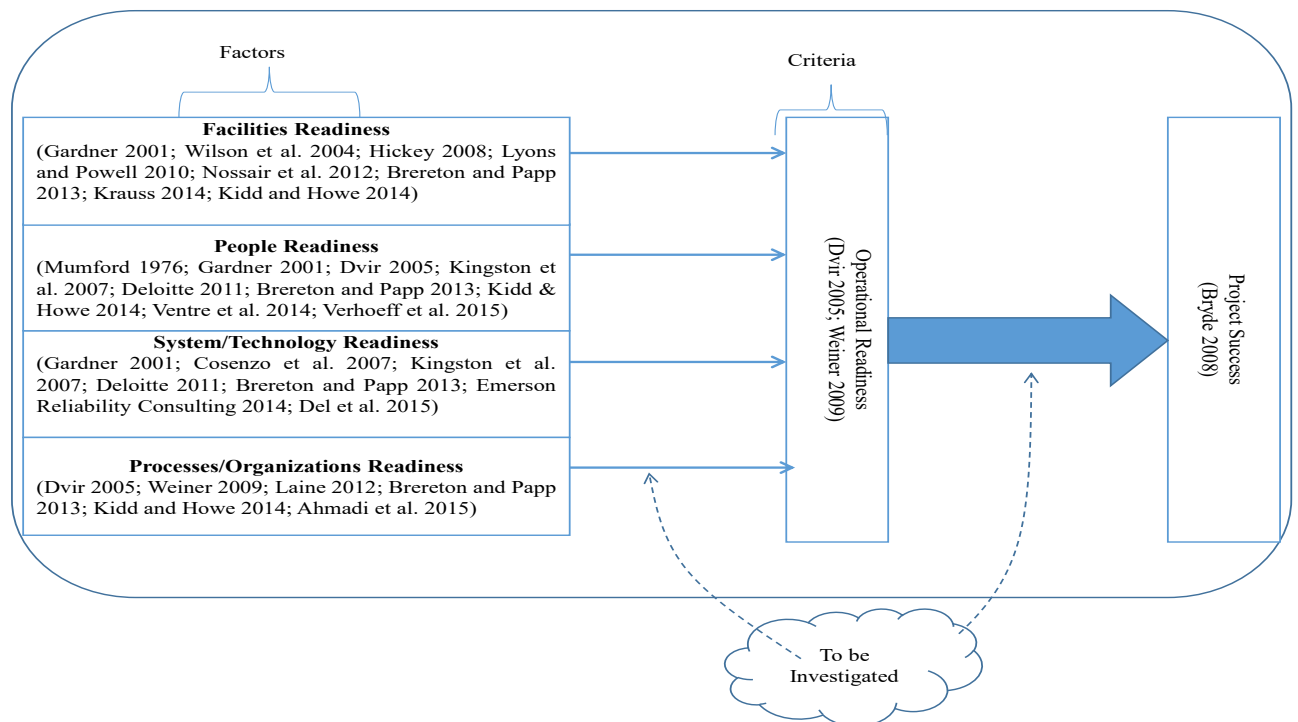


Figure 2. The Operations readiness concept

Following Bryde (2008) and Brady and Davies (2010), Figure 2 further provides for various relationships between operations readiness and the degree of non-occurrence of ‘*disastrous openings*’ (in effect, project-operations transition success). While some of these relationships are apparent from literature, others are our own propositions, which will assume the form of hypotheses (Figure 3).

Hence, altogether, five hypotheses are proposed;

Hypothesis #1: ‘*Facilities readiness*’ factors positively correlate with operations readiness.

Hypothesis #2: ‘*People readiness*’ factors positively correlate with operations readiness.

Hypothesis #3: ‘*System/technology readiness*’ factors positively correlate with operations readiness.

Hypothesis #4: ‘*Organization/processes*’ factors positively correlate with operations readiness.

Hypothesis #5: Operations readiness positively correlates with project success.

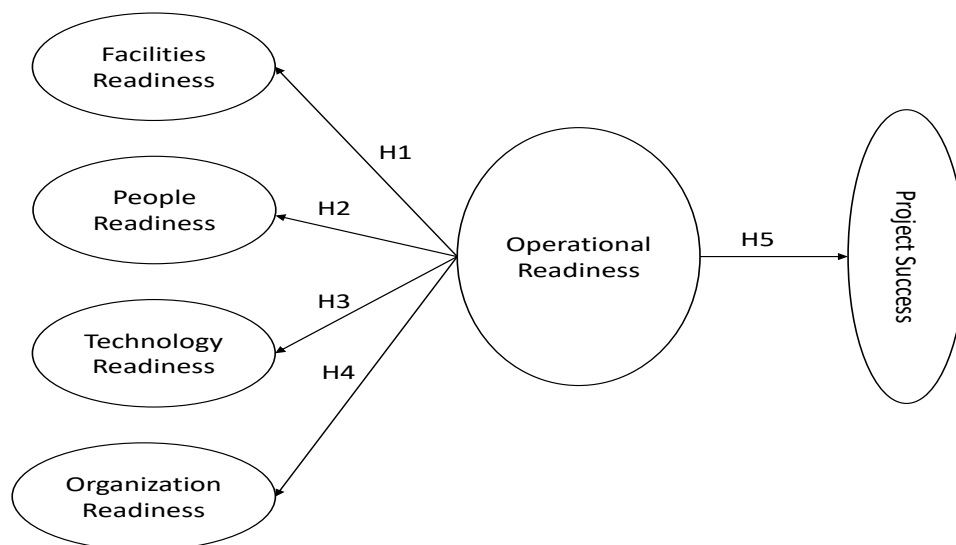


Figure 3. Hypothesized relationship: Operations readiness variables and project success).

We test these hypotheses in order to establish key interactions between the primary factors perceived to influence operations readiness in large infrastructure projects, and perceived influence on the degree of non-occurrence of ‘*disastrous openings*’ (project success). This will serve as an indirect means to validate the key readiness factors arising from the research, recognizing however that no single readiness factor is, in isolation, likely to prevent the

occurrence of '*disastrous openings*' of complex multi-stakeholder infrastructure projects.

4.4 Stage 4 - The Delphi study

Having identified the four key operations readiness elements that will form the basis of any risk-focused typology as '*facilities readiness*', '*people readiness*', '*system/technology readiness*' and '*organization/processes*', the next stage of the study was to assess their varying levels of perceived criticality. To undertake such assessment, the next phase of the study involved a Delphi study. Ten operations, project and ORAT experts (two from academia and eight from industry) were engaged. The experts were selected based on minimum levels of professional experience similar to that adopted during the *categorizations of the operations readiness factors*.

The questions presented to the expert group were drawn from four operations readiness questionnaires. The first questionnaire was the Airport Terminal Facility Activation Techniques Questionnaire (Lyons and Powell 2010). This questionnaire focuses on capturing '*lessons learned*' (Williams 2008) from successful openings of airport terminals. The manual is quite comprehensive and consists of eight chapters covering a range of topics ranging from discussion on facility activation to activation tools. Our review of this document suggested its limited attention to two emergent operations readiness factors: (i) '*Resourcing*' (for example, the manual had paid limited attention to staff engagement) and (ii) '*System readiness*'. To cater for the '*Resourcing*' limitation, the questionnaire to be used in the Delphi study was augmented with the Patient Management System Operations readiness questionnaire produced by NHS Ayrshire & Arran (2012). Of particular relevance is that this questionnaire focuses on ensuring that systems' users are fully trained. Arguably, this requirement also feeds into the '*System readiness*' operations readiness factor. To address the '*System readiness*' limitation in the Airport Terminal Facility Activation Techniques Questionnaire, we incorporated elements of the Software Support Qualitative Assessment Methodology Volume produced by the United States Army (McCracken et al. 1991). Doing so also allowed for the much broader '*military readiness*' construct to be incorporated into the Delphi study. Finally, we also employed aspects of the Activation and Operational Planning Transition questionnaire (Wilson et al. 2004). This was done in order to ensure that key risk categories vital to effective transition from project completion to commencement of operations were captured.

Following the development of the combined questionnaire, their constituent questions were modified to fit the context of this study. A total of 81 questions were presented to the expert group. In order to ensure that the questions fed into a desired risk-focused typology,

they were grouped against the four key operations readiness elements developed during the *categorizations of the operations readiness factors* (Section 4.3). The first version of the questionnaire consisted of 14 '*facilities readiness*' factors, 16 '*people readiness*' factors, 25 '*system/technology readiness*' factors, and 40 '*organization/processes*' factors. All questions were based on a five-point Likert (1932) scale². Recognizing *a priori* that all factors were to be assessed based on their level of criticality, our five-point judgment scale ranged from '*extremely critical*' to '*not critical at all*'.

In the first phase of the Delphi study (Delphi 1) the panel was required to indicate the requirements of each statement by ticking a box based on their perceived criticality for complex multi-stakeholder infrastructure projects. Where necessary, they were invited to provide additional comments. The second round of the Delphi study (Delphi 2) provided the expert panel with response weightings for each factor from round one. A detailed discussion then took place between the panel experts regarding differences in assigned weightings. The third round (Delphi 3) was based on the second round's discussions and clarification of factors. This involved a further administration of the questionnaire, eliciting an 80% response and enabling the expert panel members to vary some of their responses and comment on additional factors to be considered. A Relative Importance Index (*RIX*) was then developed to convert the scores into decimal figures using a weighting formula (Kometa et al. 1994). Final refinement of the outcome of Delphi 3 led to the final list of operations readiness factors: as such, '*facilities readiness*' comprised seven items, there were eight items for '*people readiness*', 15 items for '*system/technology readiness*' and 24 items for '*organization/processes*'.

4.5 Stage 5 - The pilot study

The next stage of the study involved piloting. This was undertaken between October and November 2016. Project, operations and ORAT practitioners working across the four major airports in the United Arab Emirates (Dubai International Airport; Abu Dhabi International Airport, Al-Maktoum International Airport and Sharjah International Airport). The questionnaires were distributed with the assistance of professional contacts within Dubai Aviation Engineering Projects. Where possible, respondents were also asked to disseminate the questionnaires among their own professional contacts and networks.

On completion of piloting, a total of 150 responses were received. Of the respondents, 63% were initially from Dubai International Airport (a point of concern leading to specific

² The final list of questions (excluding standard demographic questions) is available on request.

efforts during the main study to increase the response rates from the other three airports). The majority of respondents (approximately 80%) were middle to senior managers of which a majority (again, approximately 80%) had at least eight years of relevant professional experience. Ascertaining that response rates for some items were low (24% in one case), it was determined that the final questionnaire will be subject to appropriate linguistic modifications. Following this, Cronbach's Alpha's (α) were measured at above 0.85 for each of the constructs and all items were deemed suitable for use in the final survey questionnaire.

4.6 Stage 6 - The main study

The final questionnaire study aimed to establish: (i) the inter-relationships between the operations readiness factors and (ii) the overall relationship between operations readiness factors and the degree of non-occurrence of '*disastrous openings*' (in effect, project-operations transition success). The final questionnaire was structured against six sections. Respondents were requested to rate each question which was presented in a sequential manner. The first and second sections addressed consent and respondent demographic information. Questions three to six focused individually on the four different operations readiness factors that emerged from Delphi 3. Each of the items of the different factors was rephrased into a question. Thus, for example, item OR8 – '*Decisions should be taken by the activation team in a timely manner, and the decisions should be communicated across the planning organization*' – was rephrased into a question asking 'To what extent are you of the opinion that '*decisions should be undertaken in a timely manner by the activation team and communicated right across the entire planning organization?*'. Responses were framed against a five-point Likert (1932) scale ranging from 'Strongly disagree' = 1 to 'Strongly agree' = 5.

The targeted respondents were, once more, Project, operations and ORAT practitioners working across the four major airports in the United Arab Emirates. Targeting this group in the study enabled us not only to focus on their crucial role in daily operations, but also more specifically on how this specific group, arguably at the centre of operations readiness, may use and eventually will be impacted by risk-focused '*known-unknown*' knowledge.

Although academic commentary on convenience sampling in management studies alludes to a number of research limitations, such as lack of generalizability (see Brewis 2014), this approach was deemed most appropriate in this study noting the lack of a sampling frame of relevant respondents. Data collection commenced in December 2016. The survey was administered using *SurveyMonkey*. It is important to highlight that in examining the most commonly engaged readiness factors that may mitigate against disastrous commencement of

operations immediately after successful project completion (delivery), respondents were being called upon to reflect upon their *entire* professional experiences as against experiences tied only to particular projects. However, it is acknowledged that a number of the respondents, while not providing responses framed against a specific project, were likely to have their current projects in mind. For this reason, emails with a brief description of the study were sent to each survey participant with a link back to the website. In line with prior research undertaken by Ojiako et al. (2011), respondents had been given advance notice of the oncoming study, the importance of the study for practice and potential lessons to be learned from emerging findings (see Williams 2008; Venkatachalam et al. 2019).

A total of 724 questionnaire responses were received. Of the 724 respondents, where responses had more than five questions not answered, they were excluded from the analysis of data. In effect, these instances were considered and treated as missing values. A decision to exclude these specific questionnaires related to concerns that their inclusion was very likely to distort inferences gleaned from the data set. The authors are not aware of studies that have explicitly determined a relationship between unanswered questions and exclusion as missing values. There were 91 such questionnaires that had five or more unanswered questions. These questionnaires were deleted using the *listwise* deletion method (Lombardi et al. 2012), thus leaving 633 valid responses for analysis ($n = 633$ cases).

5. The findings

5.1 Overview of respondents

A brief breakdown of the respondents is as follows. Of the total respondents, 87.7% were male while 12.2% were female. To an extent, this is in line with assertions made in the literature that the operations (Edwards 1987) and project management profession (Henderson et al. 2013; Ojiako et al. 2015) remains male-dominated. In fact, this is a long-standing assertion argued in general management literature (see, for example, Simpson 1998).

The majority of respondents (63%) were project, operations and ORAT practitioners involved with Dubai International Airport. This was followed by Abu Dhabi International Airport (19.3%), Al-Maktoum International Airport (10.3%) and Sharjah International Airport (7.4%). In terms of managerial level, 33.2% were senior-level managers and executives, 45.5% of the respondents were mid-level managers and 18.2% were field-level (lower-level) managers. The distribution of this sample in terms of project level is important for two reasons. The first is the availability of studies that suggest that individual project role has an impact on success and failure decisions in projects judgments (see Chipulu et al. 2015; Ojiako et al. 2014,

2015). Second, studies by Zimmermann et al. (2018) point to lower- to middle-level managers increasingly taking the front line (and proactive) roles in the design of solutions for their organizations. In terms of project, operations and ORAT experience, approximately 31% had over 20 years' experience, about the same proportion (31.6%) had between 8 and 13 years' working experience while 20.7% had between 14 and 19 years' experience.

To assess for common method bias, Harman's single-factor test was conducted using un-rotated factor analysis for all the questionnaire items (shown in the first and second columns of Table 1). This was forced to single factor using eigenvalue greater than one (Sariola and Martinsuo 2016). No single factor accounted for more than 50% of the variance, which indicated common method bias was not likely to be a significant issue. We assessed for normality by looking at skewness and kurtosis (Shah and Goldstein 2006, p. 157). This did not show any violation to normality, thus no items were removed. We further heeded some literature (Jackson et al. 2009; Byrne 2016) which recommended checking for multivariate normality (*MVN*), before then conducting structural equation modelling analyses. A plot of the regression standardized residual dependent variable was grouped around the normal probability line (Elliott and Woodward 2007; Kim 2014). This allowed us to rate the assumption of multivariate normality as being met for this dataset. To assess linearity and homoscedasticity (homogeneity of variance) we used the regression function to regress the four project success predictor factors (Tabachnick and Fidell 2007). This showed a random scatter of points rather than a *U*-Shape, establishing linearity and homoscedasticity (Tysseland 2008). Cronbach's Alphas (α) ranged from .928 to .987.

5.2 Confirmatory factor analysis

As this research used a second-order factor, confirmatory factor analysis (CFA) (Shay et al. 1991) was used for first-order and second-order models (Chen et al. 2005). This tested scale validity, representing how well the measures reflected their intended constructs.

The operations readiness model comprised second-order constructs represented by four factors with 52 items; as such: '*facilities readiness*' comprised seven items; there were six items for '*people readiness*', 15 items for '*system/technology readiness*' and 24 items for '*organization/processes*'. The operations readiness model was subjected to confirmatory factor analysis with maximum likelihood. The results displayed in Table 1 (below) indicate a good fit to a four-factor model, as affirmed by the outcome of the various statistical tests shown in the bottom part of the table. All of the values of the model's fit statistics are either below or above the required benchmark for a good fit.

Table 1. Operations readiness model confirmatory factor analysis with maximum likelihood.

	Chi-square(χ^2 test) = 3160.360, p= .000							
	Absolute Fit Measures						Incremental Fit Measures	Parsimonious Fit Measures
	<i>DF</i>	χ^2 test /df	<i>GFI</i>	<i>RMSEA</i>	<i>SRMR</i>	<i>TLI</i>	<i>CFI</i>	<i>AGFI</i>
Benchmark		< 3.00	\geq 0.900	< 0.08	\leq 0.08	\geq 0.90	\geq 0.90	\geq 0.80
Operations readiness Model	1209	2.61	0.83	0.05	0.02	0.94	0.94	0.81

*Note: χ^2 test = Chi-square; df = degree of freedom; Normed chi-square or ratio of likelihood (χ^2) to degrees of freedom = χ^2 test /df;

GFI = Goodness of fit index; *RMSEA* = Root mean square error of approximation; *SRMR*= The Standardized Root Means Square Residual; *TLI*= Tucker–Lewis Index; *CFI* = Comparative fit index; *AGFI* – Adjusted goodness of fit index; *TLI* = Tucker-Lewis index (Hu and Bentler 1998); *CFI* = comparative fit index (Ika 2015); *AGFI* = adjusted goodness-of-fit index (Liu et al. 2004; Zhang and Li 2016) relating model fit to model complexity.

Additionally, proportion of variance explained (R^2) statistics was employed which are all greater than 0.40 (Salvador *et al.* 2014). This provided additional empirical support that each item was significantly linked with its theoretical construct. One item (OR20) required removal from the ‘*Organization/process readiness*’ factor. Two items (PR2 and PR8) were removed from ‘*People readiness*’ to make sure that all the items retained loaded strongly on the construct. Results are presented in Table 2, below.

Table 2. Confirmatory factor analysis with standardized regressions.

Operations readiness - Composite Reliability (0.99); Average variance extracted (0.68)	Items	Standardized loadings	P	t-Value
facilities readiness	FR	0.757	***	18.270
people readiness	PR	0.890	***	21.251
system/technology readiness	TR	0.99	***	
organization/processes	OR	0.912	***	24.518
Facilities readiness - Composite Reliability (0.90); Average variance extracted (0.56)	Items	Standardized loadings	P	t-Value
Operational trials and simulation with critical stakeholders.	FR1	0.777	***	20.98

Ensure pre-occupancy stocking of all maintenance and operational supplies for all stakeholders.	FR2	0.711	***	18.763
New processes and forms will be created and signed off by operations stakeholders.	FR3	0.787	***	21.385
Availability of supporting department from contractors and consultant during the initial phase of operations.	FR4	0.705	***	18.655
Ensure that all the new fit outs and furniture installation and acceptance are completed.	FR5	0.634	***	16.446
Availability of operational and maintenance procedures and processes.	FR6	0.838	***	23.137
Availability of all the new operating dependencies and move sequences.	FR7	0.79		
People readiness - Composite Reliability (0.93); Average variance extracted (0.70)	Items	Standardized loadings	P	t-Value
Government agencies such as police, immigration, and customs should be involved in the operational readiness program.	PR1	0.768		
Ensure and maintain staff's safety and security during the initial move and operations.	PR3	0.858	***	23.68
Arrange and ensure staff training on new building systems.	PR4	0.879	***	24.424
New understanding and familiarization should be provided to the maintenance and operations team.	PR5	0.878	***	24.365
Availability of all the new staff's operating dependencies and move sequences.	PR6	0.829	***	22.678
New training material should be accessible to the maintenance and operation team.	PR7	0.817	***	22.262
System/technology readiness - Composite Reliability (0.97); Average variance extracted (0.70)	Items	Standardized loadings	P	t-Value
Manage the safety and operational risks associated with the activation of the new systems.	TR1	0.845	***	29.814
All manuals and documentation to be made available during operational readiness and before actual operations.	TR2	0.776	***	25.424
Manage the impact on existing operations.	TR3	0.826	***	28.543
Availability of supporting department from suppliers and vendors during the initial phase of operations.	TR4	0.766	***	24.875
Ensure full testing and commissioning and integration of the critical systems of the new facility.	TR5	0.866	***	31.346
Ensure the validation and communication of the new phone numbers; new computer addresses to all relevant stakeholders	TR6	0.817	***	27.915

and users.				
Ensure system integration of the new facility to existing systems.	TR7	0.839	***	29.386
A plan for specialty disconnect/ reconnect requirements	TR8	0.816	***	27.847
Ensure adequate training and familiarization is provided for all the new maintenance and operational staff.	TR9	0.871	***	31.804
Operational trials and simulation for the new systems with critical stakeholders.	TR10	0.852	***	30.313
Ensure pre-occupancy stocking of all maintenance and operational supplies (spares) for the critical systems of all stakeholders.	TR11	0.78	***	25.696
Support and ensure the relocation of stakeholders' existing equipment as planned, with minimal operating disruptions.	TR12	0.836	***	29.22
Ensure and test for integration of the new facility to the existing systems.	TR13	0.862	***	31.051
Availability of all the new operating dependencies and move sequences.	TR14	0.88		
Ensure adequate skills and competencies for all maintenance and operations staff of the new facility.	TR15	0.867	***	31.497
Organization/process readiness - Composite Reliability (0.98); Average variance extracted (0.70)	Items	Standardized loadings	P	t-Value
Operational readiness plan should be part of the project overall planning schedule.	OR1	0.812	***	25.259
Documentation of the escalation process and communicating it to all relevant stakeholders of the new facility.	OR2	0.883	***	28.989
Establishing joint control room with all the stakeholders for the move sequence and new operations.	OR3	0.79	***	24.231
Ensure and maintain passenger safety and security during the initial move and operations.	OR4	0.857	***	27.562
A checklist/reporting mechanism is necessary for used with the operational readiness program.	OR5	0.874	***	28.487
Activation and operational readiness plan will be established early during the project.	OR6	0.801	***	24.762
Ensure all roles and responsibilities (operator, maintainer and user) documentation is signed off by relevant stakeholders.	OR7	0.878	***	28.731
Decisions should be taken by the activation team in a timely manner, and the decisions should be communicated across the planning organization.	OR8	0.832	***	26.277
Confirmation that all roles and responsibilities (operator,	OR9	0.896	***	29.733

maintainer and user) are fully documented and communicated to all stakeholders.				
A clear protocol for communication during the operational readiness program is required.	OR10	0.847	***	25.137
Maintain lines of communication with all the stakeholders during initial start-up and operations.	OR11	0.87	***	28.279
A formally dedicated activation and operational readiness team is required.	OR12	0.844	***	26.882
Ensure that regulatory and compliance requirements for all the processes and procedures are met.	OR13	0.897	***	29.806
Confirmation of an escalation process to higher management during operational readiness.	OR14	0.861	***	27.778
New facility objectives and performance outcomes should be documented and signed off by the operations team.	OR15	0.86	***	27.737
Progress update on the operations readiness plan will be managed and communicated to all stakeholders.	OR16	0.84	***	26.688
The project should have phased (soft) opening as part of its operational readiness plan.	OR17	0.73	***	21.578
Define and communicate the supporting department responsibilities during the initial phase of operations that includes the contractor and consultant as part of the stakeholders.	OR18	0.834	***	26.357
Prepare and communicate the grand opening activities.	OR19	0.746	***	22.275
Arrangement and agreement on the public communications, including service-scheduling impact.	OR21	0.774	***	28.153
Availability of new business and administration operational procedures and processes for all stakeholders.	OR22	0.829		
Prepare and communicate all the new policies and procedures to stakeholders of the new facility.	OR23	0.837	***	31.765
A formal activation and operational readiness program.	OR24	0.882	***	28.947
<i>P</i> = critical (<i>p</i> -value) = significance value. *** <i>p</i> < 0.001”.				

The factor loading of items for the first-order and second-order constructs, which is above 0.5 as per Shah and Goldstein’s (2006) requirement, shows a good indication of items on its latent variables for the model. Moreover, all the operations readiness constructs showed strong composite reliability at $CR > 0.7$. To put this in context, Ika (2015) and Low et al. (2015) recommend a minimum threshold for composite reliability of at least 0.70 (or 0.60 for an exploratory study). The high values of CR indicate excellent internal reliability for items within

their respective factors. Furthermore, due to average variance extracted (AVE) values for each construct exceeding the acceptable threshold of 0.5 (as recommended by Low et al. 2015), a convergent validity was deemed acceptable for all the factors. The project success model was further subjected to confirmatory factor analysis with maximum likelihood (ML). Results showed a good fit to a single factor model. The project success measurement model fit indices are presented in Table 3, below.

Table 3. Project Success Measurement Model indices.

	Chi-square (χ^2 test) = 256.847, $p = .000$							
	Absolute Fit Measures						Incremental Fit Measures	Parsimonious Fit Measures
	DF	χ^2 test/df	GFI	RMSE A	SRM R	TLI	CFI	AGFI
Benchmark		< 3.00	≥ 0.900	< 0.08	≤ 0.08	≥ 0.90	≥ 0.90	≥ 0.80
Project success Model	67	3.83	0.941	0.067	0.03	0.96	0.97	0.904

Table 4 shows factor loadings of items. The first eleven of these project success items were drawn from Bryde (2008). Three additional items including were drawn from the literature ‘Smoother start-up of the project’ (Liu 1999), ‘Stakeholder satisfaction’ (Davis 2014), and a ‘Quick return on investment’ (Farid et al. 1989). The project success construct, showed strong composite reliability. Convergent validity and discriminant validity were used to validate the model constructs.

Table 4. Confirmatory factor analysis with standardized regressions.

	Items	Standardized loadings	P	t-Value	Composite reliability	Average variance extracted
Item	PS "Project Success."				0.95	0.59
<i>Meet time objectives</i>	PS1	0.598	***	16.1		
<i>Meet cost/budget objectives</i>	PS2	0.597	***	17.27		
<i>Deliver tangible benefits for the organization</i>	PS3	0.649				
<i>Customers are satisfied with project outcomes</i>	PS4	0.783	***	17.3		
<i>Project specifications met by handover</i>	PS5	0.82	***	17.95		
<i>Stakeholder satisfaction with project management approach</i>	PS6	0.832	***	18.13		

<i>Project team members' satisfaction with project management approach</i>	PS7	0.79	***	17.44
<i>Clearly identified benefits from the project</i>	PS8	0.83	***	18.09
<i>End user satisfaction with project outcomes</i>	PS9	0.737	***	16.48
<i>Use of effective project management processes</i>	PS10	0.814	***	17.75
<i>Overall satisfaction with project outcomes</i>	PS11	0.743	***	16.54
<i>Smooth project start-up</i>	PS12	0.816	***	17.86
<i>Overall stakeholder satisfaction</i>	PS13	0.824	***	18.03
<i>Return on investment</i>	PS14	0.844	***	18.38
<i>P = critical (p-value) = significance value. *** p < 0.001".</i>				

Table 5 presents average variance extracted (*AVE*) values for the constructs and confirms their convergent validity.

Table 5. Convergent validity table.

Construct	<i>AVE</i>
Operations Readiness	0.68
<i>'facilities readiness/processes'</i>	0.56
<i>'people readiness'</i>	0.7
<i>'system/technology readiness'</i>	0.7
<i>'organization/processes'</i>	0.7
Project Success	0.59

The square roots of the *AVEs* were also calculated. The values were then compared to the inter-correlations' values between the constructs (Table 6). This exercise found model constructs to possess discriminant validity. It further indicated that all constructs shared more variance with their indicators than with other constructs.

Table 6. Values comparison.

	Operations Readiness	Project Success
Operations Readiness	0.82	
Project Success	0.73	0.76

5.2 Testing the structural model

To test the structural model, we referred back to the conceptual model to confirm its structure in terms of relationships among the constituent variables. Our focus lay on the SEM key variables, which are also called latent constructs (Jackson et al. 2009). We focussed on the latent constructs because our overall aim is to understand the relationships between these latent constructs. For example, we are interested in how the two latent constructs of operational readiness and project success relate to each other. The latent constructs cannot be measured directly and are only measured by their indicators (Fellows and Liu 2003). For the operations readiness structural model of this study, this step focused on the relationship between operations readiness (as the exogenous construct) and project success (as the endogenous construct) (Hair et al. 2009). This relationship was depicted earlier in Figures 2 and 3.

Casual pathways had been presented, based on the proposed relationships between the study variables. The second-order reflective model was chosen since it was assumed that observed factors are a reflection of ‘*Operations readiness*’ as a ‘*Project success*’ variable. As depicted in Figure 3, the operations readiness factors (‘*facilities readiness*’, ‘*people readiness*’, ‘*system/technology readiness*’ and ‘*organization/processes*’), which co-vary with each other, were considered indicators of the same overall latent variable, ‘*Operations readiness*’. This implies that each operations readiness factor *indirectly* influences the ‘*Project success*’ variable through the overall operations readiness factor. Such influences are the essence of the *Operations and change readiness* literature that was discussed earlier in section 3.2.

Our resulting ‘*Operations readiness*’ model therefore comprised of a second-order variable bearing four factors and a first-order construct represented by one variable with 14 project success items which were taken from Bryde (2008), (Liu 1999), (Davis 2014), and (Farid et al. 1989) and shown in Table 4. This structure model was subjected to analysis with maximum likelihood (*ML*). The results (Table 7) showed a good fit as a structure model.

Table 7. Structure model Chi-square results and GOF indices.

Chi-square (χ^2 test) = 4790.630, p= .000								
Absolute Fit Measures					Incremental Fit Measures		Parsimonious Fit Measures	
	DF	χ^2 test /df	GFI	RMSEA	SRMR	TLI	CFI	AGFI
Benchmark		< 3.00	\geq 0.900	< 0.08	\leq 0.08	\geq 0.90	\geq 0.90	\geq 0.80

Operations Readiness Model	1987	2.411	0.806	0.067	0.043	0.932	0.935	0.791
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5.3 Hypotheses testing and path analysis

Path analysis and parameter estimates were then used to estimate strength and directionality of relationships within the ‘*Operations readiness*’ structural model. The results of the path analysis are presented in Table 8, with 65 measurement items identified for the two latent constructs, using the five hypotheses *H1-H5* above.

Table 8. Path analysis for the operations readiness model.

Hypothesis	Hypothesis Paths			Estimate	SE.	CR	P	β
H1	‘ <i>facilities readiness</i> ’	<---	Operations readiness	0.7	0.04	18.34	***	0.76
H2	‘ <i>people readiness</i> ’	<---	Operations readiness	0.88	0.04	21.19	***	0.89
H3	‘ <i>system/technology readiness</i> ’	<---	Operations readiness	1				0.98
H4	‘ <i>organization/processes</i> ’	<---	Operations readiness	0.9	0.04	24.75	***	0.92
H5	Project Success	<---	Operations readiness	0.64	0.04	14.93	***	0.73

Note: Estimate = standardized regression weights (path estimate), S = standard error, CR. =critical ratio (*t*-value), *P* = critical (*p*-value) = significance value. *** *p* < 0.001

Results of the hypotheses testing presented in Table 8 show statistical significance and directionality findings. In *H1*, *H2*, *H3* and *H4* all of the readiness factors are positively correlated and predict the second-order variable of ‘*Operations readiness*’, whereas the relationship between ‘*Operations readiness*’ and ‘*Project success*’ is positively correlated and predicts project success with a *CR* value of 14.93 (>1.96). Further to this, correlation analysis was conducted among the ‘*Operations readiness*’ factors shown in Table 9. This suggests the ‘*Operations readiness*’ factors to be positively correlated, with some of the bivariate correlations above 0.60 (Ika 2015). In addition, it is shown that the four operations readiness factors *intercorrelate* positively. All of them have values higher than (0.60), which supports *H1*, *H2*, *H3* and *H4*, as well as the existence of an ‘*Operations readiness*’ variable with second-order latency.

Table 9. Correlation matrix.

	<i>'facilities readiness'</i>	<i>'people readiness'</i>	<i>'system/technology readiness'</i>	<i>'organization/processes'</i>
<i>'facilities readiness'</i>	1			
<i>'people readiness'</i>	.717**	1		
<i>'system/technology readiness'</i>	.687**	.841**	1	
<i>'organization/processes'</i>	.648**	.757**	.886**	1

** $p < 0.01$.

The strong positive impact on operational readiness on project success supported $H2$ and is shown in the final structure model below (Figure 4).

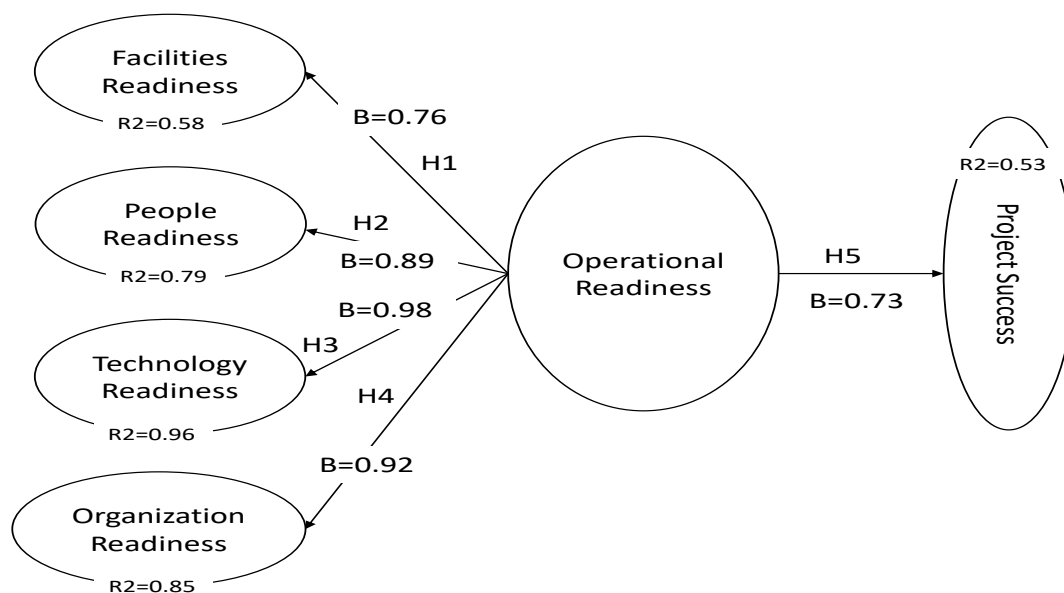


Figure 4. Results of the 65-item structural equation model.

The results of multiple squared correlations are shown in Table 10 (below). The value is between 0 and 1. The closer to 1 it is, the closer the model will be to predict the results and articulate a trend. Specifically, we can infer that *'Operations readiness'* significantly and positively influences and impacts upon *'Project success'*.

Table 10. Squared multiple correlations.

Item	R^2
<i>'Project success'</i>	0.53
<i>'facilities readiness'</i>	0.58
<i>'people readiness'</i>	0.79

<i>'system/technology readiness'</i>	0.96
<i>'organization/processes readiness'</i>	0.85

5.0 Discussions

The present study has found significant and positive standardized regression weights (t) between *'Operations readiness'* and each of the four readiness factors as follows: *'system/technology readiness'* (.98), *'organization/processes' readiness* (.92), *'people readiness'* (.89), and *'facilities readiness'* (.76). More specifically, the study found that *'Operations readiness'* (as a second-order latent variable) our results suggest increases in operational readiness are strongly associated with increases in project success. In effect, as relates to the question, what is the relationship between *'Operations readiness'* factors and *'Project success'*, indications are that around half of the level of understanding of what is *'Project success'* can be attributed to operations readiness. Overall, the findings of the study were in line with many earlier developed theoretical propositions regarding the relationship between *'Operations readiness'* and successful infrastructure implementation (Armenakis et al. 1993; Weiner et al. 2008; Brady and Davies 2010). The findings further lead to the conclusion that the four *'Operations readiness'* factors express the collective wisdom and experience of project managers, project risk managers and ORAT practitioners regarding key risk categories that matter to bring about an effective transition from project completion to commencement of operations. They are, by that token, significant focal points of abstract risk knowledge that guide risk imagination and ORAT practice as complex multi-stakeholder projects enter, pass through, and emerge from, such transitions.

To provide context, it is important to reiterate that the four readiness factors are perceived as risk categories for project risk identification (encompassing risk intelligence gathering) and ORAT practice purposes. More fully, the four readiness factors are regarded as functioning in these ways to drive knowledge production as has been theorized from various 'knowledge-based' organizational theory standpoints (see Grant 2002). However, this four-fold risk ontology need not and, it is further stressed, absolutely *should* not be interpreted simplistically as implying the existence of four risk silos within which risk knowledge can be produced separately. Quite the contrary, and with reference to as the evidence base of this study (Table 7), it is contended that the four readiness factors should be used as risk categories *in conjunction* with one another. Employed together, it is more likely that these risk categories will provide

appropriate granularity for the construction of risk narratives. To reiterate, the interrelationships of the various readiness factors are all illustrative of the relational risk ontology, which may be necessary when planning and controlling for risk so as to prevent '*disastrous openings*' during the transition from project completion to the commencement of operations. Accordingly, the higher-order general readiness factor (Table 7) is interpreted as standing for a healthy managerial appreciation that planning for readiness and ongoing success in operations is a holistic endeavour that should come naturally to operations, project and ORAT practitioners. In other words, it is asserted that the higher-order domain corresponds to a holistic managerial concern with readiness whereby risk ontology is relational and mechanistic by explicitly connecting the four domains. Marshall et al. (2019) explored this issue arguing that relevant literature on both readiness and commissioning issues all overlapped considerably in their basic subject matter - thereby underscoring the importance of readiness factor interrelationships.

Project risk management and ORAT are expected to operate at a high level of complexity reduction by matching discrete risks to controls (Ojiako et al. 2010; Marshall and Ojiako 2013; Williams 2017). This cannot possibly be adequate for complex multi-stakeholder projects with complex success outcomes (driven by multiple stakeholders). By contrast, use of a relational risk ontology built from awareness that each of the four readiness domains is vital can provide a more appropriate level of complexity reduction, both for rendering complex risk visible and for developing risk discourses that are unifying for the very different stakeholders who need to collaborate on complex multi-stakeholder infrastructure projects.

As 'success' had been considered to be largely determined by the avoidance of '*disastrous openings*' (Brady and Davies 2010; p. 152), the findings from the study add considerable weight to our claims that risk categories are likely to matter at the points of transition from project completion to commencement of operations. These present findings are in line with earlier cited readiness (see, for example, Stevens 2013; Vakola 2013; Krauss 2014; Shokri et al. 2016) and assurance (Takim and Adnan 2008) studies, which all identified either global operations readiness or individual operations readiness risk categories as significantly impacting project success. For example, Takim and Adnan (2008) found that key operational assurance factors of (i) system warranties, (ii) commissioning, (iii) close-out and handover processes, (iv) operational fit for purpose simulations, and (v) constructions defect rectification, together accounted for 12.15% of project success variance.

6.0 Conclusions

The success of projects is often divided into the delivery of the project outputs (to time/cost/quality), and realizing the planned benefits or outcomes of the project (e.g., Williams 2016). Increasingly, the focus is moving to the latter as becoming more effective and efficient at delivering project outputs but seemingly no better at realizing the benefits of those projects. This is often particularly apparent when a delivered product or piece of infrastructure is completed and moves into service. The importance of such phased transitions is underlined by recent calls for further research by Locatelli et al. (2018). Airports have seen some well-publicized failures at this point, representing '*disastrous openings*'. A project manager will be concerned with the delivery of the product and the risks to that delivery. However, a project owner is concerned with the benefits that will accrue from the use of that product and risks to achieving those benefits.

This study sought to explore the essential readiness factors commonly engaged in preventing '*disastrous openings*' of complex multi-stakeholder infrastructure projects. Findings from the study suggest a risk-focused operations readiness typology theorized as abstract '*known-unknown*' knowledge. Such knowledge we argue, will serve to enable the transition of '*unknown-unknowns*' into concrete '*known-knowns*' that prevent past mistakes from being repeated. The findings can be generalized as applicable across the range of projects that share similar characteristics with nationally operated airport projects. These are projects that are complex, have multiple and heterogeneous stakeholders and may be commissioned against contradictory and sometimes contested objectives.

The study considered specific operations readiness factors for both managing risks and ensuring effective ORAT practice associated with the transitions from project completion to the first day of commencement of operations. The line of enquiry adopted was fundamentally concerned with selecting optimal risk categories for channelling risk identification effort, or indeed for what might be phrased metaphorically as '*situating project risk radars*'. This was to ensure that operations, project and ORAT practitioners were not only able to understand where risks are most likely to emerge, but are clear on how to mitigate against such risks. The importance of this is clear as around half of the variability in project success was ascribed to operational readiness by respondents to the study.

In terms of theoretical contributions, this paper explored the risk to the benefit of complex multi-stakeholder infrastructure projects, focusing on '*Operations readiness*' factors. This goes beyond the standard project risk focus on delivery to an integrated view of the risk to the usefulness of projects, an important conceptual change of focus. The study further contended that through accentuating abstract categories for operations readiness, PRM and

ORAT practice would benefit from knowing *what they do not know*. In particular, the study considered that an optimized set of risk categories distilled through isomorphic learning from literature and previous projects could merge both creative risk imagination and evidence gathering for risks within new projects. These are likely to support further gains in the development of both abstract and concrete risk forecasting knowledge among managers and practitioners, helping to describe possible future risk events (possibly from likenesses to previous similar events) with probabilities assigned by expert judgment. However, this could be so in the absence of any concrete information about the emergence of the risk within the specific context.

In terms of managerial implications to manage this risk, *firstly*, ‘*facilities readiness*’ needs to be understood with reference to complex systems interactions of various kinds, suggesting it can only be planned well with intensive stakeholder collaboration. *Secondly*, ‘*people readiness*’ needs to be designed at the project stage and further cultivated during ongoing operations as it deals with the critical human element in flexible handling of change and crisis, as might conceivably relate to failures in any other readiness domain. *Thirdly*, ‘*system/technology readiness*’ is particularly critical (as indeed is reflected in our Table 10); where operational use of technology adds enormous value, both by reducing customer costs and by reducing queueing and administrative burdens. When it fails, however, the negative impact on customer experience and the potential to cause reputational and financial damage is arguably greater than for any other readiness factor. Hence, alternative and lower-technology back-up systems are required (Ojiako 2012; Ojiako et al. 2013). Of course, the ‘*facilities*’, ‘*people*’ and ‘*organization/processes*’ aspects of readiness are all vital planning issues within that context. More specific areas for attention within these categories are discussed within the paper, with particular reference to Table 2, which shows the contribution of these factors to Operational Readiness.

In conclusion, we have shown that an ‘Operations readiness’ risk category is critical in the understanding of overall project success. It can be seen as a ‘*known unknown*’ in circumstances where operations readiness practitioners judge that it must be taken seriously, even in the absence of concrete risk data showing its relevance within the specific project context. By using such readiness factors for PRM and ORAT practice, operations, project and ORAT practitioners are able to benefit from the distilled wisdom of many previous disastrous openings through the consolidation of such wisdom within an optimized specification of readiness factors, which have been judged to matter in the past. It is noted, however, that an enhancement of such wisdom will benefit from working more directly with abstract risk

category ontologies, exploring *how*, *why* and *when* its categories are used by dedicated risk management teams on complex project transitions. Detailed knowledge of how such practices relate to project success could provide an innovative conceptual focus for calculating returns from investment in such teams, and indeed, for developing the activities involved to produce the strongest results and benefits.

References

- Aaltonen, K. and Kujala, J. 2016. "Towards an improved understanding of project stakeholder landscapes." *International Journal of Project Management* 34(8): 1537-1552.
- Aladağ, H. and Işık, Z. 2018. "The Effect of Stakeholder-Associated Risks in Mega-Engineering Projects: A Case Study of a PPP Airport Project." *IEEE Transactions on Engineering Management* 99: 1-13.
- Antony, J. 2014. "Readiness factors for the Lean Six Sigma journey in the higher education sector." *International Journal of Productivity and Performance Management* 63(2): 257-264.
- Armenakis, A., Harris, S., and Mossholder, K. 1993. "Creating readiness for organizational change." *Human Relations* 46(6): 681-703.
- Artto, K., Ahola, T., and Vartiainen, V. 2016. "From the front end of projects to the back end of operations: Managing projects for value creation throughout the system lifecycle." *International Journal of Project Management* 34(2): 258-270.
- Barzily, Z., Marlow, W., and Zacks, S. 1979. "Survey of approaches to readiness." *Naval Research Logistics* 26(1): 21-31.
- Bhattacharyay, B. 2010. *Estimating Demand for Infrastructure in Energy, Transport, Telecommunications, Water and Sanitation in Asia and the Pacific: 2010-2020*. ADBI Working Paper 248. Tokyo: Asian Development Bank Institute. <http://www.adbi.org/working-paper/2010/09/09/4062.infrastructure.demand.asia.pacific/>, accessed 12/08/18.
- Bharadwaj, A., M. Keil, and Mahringer, M. 2009. "Effects of Information Technology Failures on the Market Value of Firms." *Journal of Strategic Information Systems* 18 (2): 66-79
- Brady, T., and Davies, A. 2010. "From hero to hubris – reconsidering the project management of Heathrow's Terminal 5." *International Journal of Project Management* 28(2): 151-157.
- Braglia, M. and Frosolini, M. 2014. "An integrated approach to implement project management information systems within the extended enterprise." *International Journal of Project Management* 32(1): 18-29.
- Brewis, J. 2014. "The ethics of researching friends: On convenience sampling in qualitative management and organization studies." *British Journal of Management* 25(4): 849-862.
- Brito, M., Lopes, R., Rocha, L., and Qualharini, E. 2016. "Beyond buildability: Operability and commissioning of industrial facilities." *Procedia-Social and Behavioral Sciences* 226, 67-74.
- Bryde, D. 2008. "Perceptions of the impact of project sponsorship practices on project success." *International Journal of Project Management* 26(8): 800-809.
- Byrne, B. 2016. *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. Routledge.
- Campbell, K., Carmichael, P. and Naidoo, J. 2015. "Responding to hostility: Evidence-based guidance for communication during planned organizational change." *Business and Professional Communication Quarterly* 78(2): 197-214.
- Cantarelli, C., Flyvbjerg, B., van Wee, B., and Molin, E. 2010a. "Lock-in and its influence on the project performance of large-scale transportation infrastructure projects: investigating the way in which lock-in can emerge and affect cost overruns." *Environment and Planning B: Planning and Design* 37(5): 792-807.
- Cantarelli, C., Flyvbjerg, B., Molin, E., and van Wee, B. 2010b. "Cost overruns in large-scale transportation infrastructure projects: explanations and their theoretical embeddedness." *European Journal of Transport and Infrastructure* 10: 1-14.

- Chen, F., Sousa, K., and West, S. 2005. "Testing measurement invariance of second- order factor models." *Structural Equation Modeling* 12(3): 471-492.
- Chipulu, M., Ojiako, U., Gardiner, P., Williams, T., Mota, C., Maguire, S., Shou, Y., Stamati, T., and Marshall, A. 2014. "Exploring the impact of cultural values on project performance." *International Journal of Operations and Production Management* 34 (3): 364-389.
- Chipulu, M., Ojiako, U., Marshall, A., Bititci, U., Williams, T., Mota, C., Shou, Y., Thomas, A., and Dirani, A. 2019. "A dimensional analysis of stakeholder saliences in the assessment of project outcomes." *Production Planning & Control*, In Press.
- Coombs, C. 2015. "When planned IS/IT project benefits are not realized: a study of inhibitors and facilitators to benefits realization." *International Journal of Project Management* 33(2): 363-379.
- Cosenzo, K., Fatkin, L., and Patton, D. 2007. "Ready or not: enhancing operational effectiveness through use of readiness measures." *Aviation, Space, and Environmental Medicine* 78(5): B96-B106.
- Croes, H. 2007. "Suvarnabhumi Airport a blend of modern western architecture with traditional Thai cultural artwork." *Airports of the World* 1-3.
- Davis, K. 2017. "An empirical investigation into different stakeholder groups perception of project success." *International Journal of Project Management* 35(4): 604-617.
- Davies, A., Gann, D. and Douglas, T. 2009. Innovation in megaprojects: systems integration at London Heathrow Terminal 5. " *California Management Review* 51(2): 101-125.
- De Araújo, M., Alencar, L. and de Miranda Mota, C. 2017. Project procurement management: A structured literature review. " *International Journal of Project Management* 35(3): 353-377.
- Durugbo, C., and Riedel, J. 2013. "Readiness assessment of collaborative networked organisations for integrated product and service delivery." *International Journal of Production Research* 51(2): 598-613.
- Dvir, D. and Lechler, T. 2004. Plans are nothing, changing plans is everything: the impact of changes on project success." *Research Policy* 33(1): 1-15.
- Dvir, D. 2005. Transferring projects to their final users: the effect of planning and preparations for commissioning on project success." *International Journal of Project Management* 23(4): 257 - 265.
- Edwards, P. 1987. "Factory Managers: Their Role In Personnel Management And Their Place In The Company." *Journal of Management Studies* 24(5): 479-501.
- El Asmar, M., Hanna, A., and Loh, W. 2013. "Quantifying performance for the integrated project delivery system as compared to established delivery systems." *ASCE Journal of Construction Engineering and Management* 139(11): 04013012.
- Elliott, A., and Woodward, W. 2007. *Statistical analysis quick reference guidebook: with SPSS example*. Thousand Oaks, California: Sage Publications.
- Farid, F., Boyer, L. and Kangari, R. 1989. "Required return on investments in construction." *ASCE Journal of Construction Engineering and Management* 115(1): 109-125.
- Fellows, R., and Liu, A. 2003. *Research methods for construction*. 3rd ed. Black- well Publishing Ltd.
- Fletcher, J., and Wind, A. 2014. "The evolving definition of cognitive readiness for military operations." In *Teaching and measuring cognitive readiness* (25-52). Springer, Boston, MA.
- Flyvbjerg, B. 2007. "Policy and planning for large-infrastructure projects: problems, causes, cures." *Environment and Planning B: Planning and Design* 34(4): 578-597.
- Flyvbjerg, B. 2009. "Survival of the unfittest: why the worst infrastructure gets built—and what we can do about it." *Oxford Review of Economic Policy* 25(3): 344-367.
- Freeman, R. 1984. *Strategic Management: A stakeholder approach*, Boston: Pitman.
- Friedman, A., and Miles, S. 2002. "Developing stakeholder theory." *Journal of Management Studies* 39(1): 1-21.
- Geraldi, J. and Söderlund, J. 2018. "Project studies: What it is, where it is going." *International Journal of Project Management* 36(1): 55-70.
- Gil, N., Miozzo, M. and Massini, S. 2012. "The innovation potential of new infrastructure development: An empirical study of Heathrow airport's T5 project." *Research Policy* 41(2): 452-466.
- Hair, J., Black, W., Babin, B., and Anderson, R. 2009. *Multivariate data analysis*. 7th edn. Upper Saddle River, US: Pearson Prentice Hall.

- Harrison, T. 2014. "Rethinking readiness." *Strategic Studies Quarterly* 8(3): 38-68.
- Hendershot, D. 2015. "Process safety: operational readiness." *Journal of Chemical Health and Safety*, 22(1): 44-45.
- Henderson, L., Stackman, R., and Koh, C. 2013. "Women project managers: the exploration of their job challenges and issue selling behaviors." *International Journal of Managing Projects in Business* 6(4): 761-791.
- Horning, S., Leung, P., Fitzgerald, A., and Mrad, N. 2012. "Operational readiness simulator: optimizing operational availability using a virtual environment." *International Journal of Aerospace Engineering* 2012, 1-8.
- Ika, L. 2015. "Opening the black box of project management: Does World Bank project supervision influence project impact?" *International Journal of Project Management* 33(5): 1111-1123.
- Jackson, D., Gillaspay, J., and Purc-Stephenson, R. 2009. "Reporting practices in confirmatory factor analysis: An overview and some recommendations." *Psychological Methods* 14(1): 6-23.
- Jennings, W., Lodge, M., and Ryan, M. 2018. "Comparing blunders in government." *European Journal of Political Research* 57(1): 238-258.
- Jian, G. 2011. "Articulating circumstance, identity and practice: toward a discursive framework of organizational changing." *Organization* 18(1): 45-64.
- Jirapong, J., Praneetpolgrang, P., and Manisri, T. 2015. "Determinant factors affecting the baggage claim systems in Suvarnabhumi Airport. In *International Conference on e-Business, 2015* (iNCEB 2015): 1-6
- Kennedy, L. 2015. "The politics and changing paradigm of megaproject development in metropolitan cities." *Habitat International* 45: 163-168.
- Kim, D. 2014. "Understanding supplier structural embeddedness: A social network perspective." *Journal of Operations Management* 32(5): 219-231.
- Kometa, S., Olomolaiye, P., and Harris, F. 1994. "Attributes of UK construction clients influencing project consultants' performance." *Construction Management and Economics* 12(5): 433-443.
- Krauss, E. 2014. "How does operational readiness assist in asset management : It surely is an operations function ?" *Australian Journal of Multi-Disciplinary Engineering* 11(1): 1-11.
- Lawry, K., and Pons, D. 2013. "Integrative approach to the plant commissioning process." *Journal of Industrial Engineering* 2013, 1-12.
- Lee, E. 2000. "The new Hong Kong international airport fiasco: accountability failure and the limits of the new managerialism." *International Review of Administrative Sciences* 66(1): 57-72.
- Lee, T., Wong, W., and Yeung, K. 2011. "Developing a readiness self-assessment model (RSM) for six Sigma for China enterprises." *International Journal of Quality and Reliability Management* 28 (2): 169-194.
- Lefevre, A. 2012. "Bangkok airport problems threaten tourist-friendly image, Reuters <https://www.reuters.com/article/uk-thailand-airport/bangkok-airport-problems-threaten-tourist-friendly-image-idUSLNE82F00W20120316>, accessed 26/06/18
- Likert, R. 1932. "A technique for the measurement of attitudes." *Archives of Psychology*, 22, 5-55.
- Liu, A., 1999. "A research model of project complexity and goal commitment effects on project outcome." *Engineering, Construction and Architectural Management* 6(2): 105-111.
- Locatelli, G., Zerjav, V. and Klein, G. 2018. "Project Transitions: Navigating Across Strategy, Delivery, Use and Decommissioning. Call for papers, *Project Management Journal*, https://journals.sagepub.com/pb-assets/cmscontent/PMX/PMJ_Call_ad_Project_Transitions_lpg_web.pdf, accessed 15/05/19.
- Lombardi, A., Conley, D., Seburn, M., and Downs, A. 2012. "College and Career Readiness Assessment: Validation of the Key Cognitive Strategies Framework." *Assessment for Effective Intervention* 38(3): 163 - 171.
- Low, W., Abdul-Rahman, H., and Zakaria, N. 2015. "The impact of organizational culture on international bidding decisions: Malaysia context." *International Journal of Project Management* 33(4): 917-931.
- Lyons, A., and Powell, D. 2010. *Airport terminal facility activation techniques*. <http://www.nap.edu/catalog/14394>, accessed 25/07/16.
- Mahring, M., and Keil, M. 2008. "Information Technology Project Escalation: A Process Model." *Decision Sciences* 39 (2): 239-272.

- Mankins, J. 2009. "Technology readiness assessments: A retrospective. *Acta Astronautica* 65(9-10): 1216-1223.
- Marshall, A., and Ojiako, U. 2013. "Managing risk through the veil of ignorance." *Journal of Risk Research* 16(10): 1225-1239.
- Marshall, A., Ojiako, U., Wang, V., and Lin, F. 2018a. "Forecasting Unknown-Unknowns by Boosting the Risk Radar within the Risk Intelligent Organisation." *International Journal of Forecasting* 35 (2): 644-658.
- Marshall, A., Ojiako, U., and Chipulu, M. 2018b. "Risk Appetite: A Futility, Perversity and Jeopardy critique of over-optimistic Corporate Risk Taking." *International Journal of Organisational Analysis* 27 (1): 51-73.
- Marshall, A., Ojiako, U., Williams, T., Al-Mazrouie, J., Lin, F., and Chipulu, M. 2019. *Risk Management as Knowledge Production: application to Fast-Tracked Complex Multi-stakeholder Airport Projects*, In Webb, H. and Al Numairy, H. "Entrepreneurial Innovations and Economic Development in Dubai and Comparisons to Its Sister Cities", pub. IGI Global.
- Maylor, H., and Turner, N. 2017. "Understand, reduce, respond: project complexity management theory and practice." *International Journal of Operations & Production Management* 37(8): 1076-1093.
- Mazumdar, M. 1969. "Uniformly minimum variance unbiased estimates of operational readiness and reliability in a two-state system." *Naval Research Logistics* 16(2): 199-206.
- McCracken, W., Mynatt, E., Smith, C., Nunamaker, J., Chang, A-M., Purdin, T., Orwig, R., and Vyas, A. 1991. *The Software Supportability Qualitative Assessment Methodology*, Pub. US Army Institute for Research in Management Information, Communications, and Computer Sciences.
- Monteiro de Carvalho, M. 2013. "An investigation of the role of communication in IT projects." *International Journal of Operations & Production Management* 34(1): 36-64.
- Morris, P. 1997. "Managing project interfaces - key points for project success. In D. Cleland, D and King, W. (eds). *Project management handbook*. 2nd edn. Hoboken, NJ, USA: John Wiley & Sons, Inc.
- NHS Ayrshire & Arran. 2012. *NHS Ayrshire and Arran patient management system MSK: operational readiness questionnaire*. <http://www.qihub.scot.nhs.uk/media/531043/1%202020%20-%20msk%20opera-tional%20readiness%20questionnaire%20-%20aa.pdf>, accessed 01/11/16.
- Nossair, A., Al-Tamimi, A., Al Amri, A., Al-Katheeri, K., Hann, T., and Finigan, T. 2012. "Mega projects integrated readiness assurance process." Abu Dhabi International Petroleum Conference and Exhibition. Abu Dhabi, UAE. 11-14 November. Society of Petroleum Engineers: Abu Dhabi, UAE.
- Ojiako, U. 2012. "Using IS/IT to enhance service delivery." *Industrial Management and Data Systems* 112 (4): 584 – 599.
- Ojiako, U., Ashleigh, M., Chipulu, M. and Maguire, S. 2011. "Learning and teaching challenges in project management." *International Journal of Project Management* 29(3): 268-278.
- Ojiako, U., Chipulu, M., Gardiner, P., Williams, T., Mota, C., Maguire, S., Shou, Y., and Stemanti, T. 2014. "Effect of project role, age and gender differences on the formation and revision of project decision judgements" *International Journal of Project Management* 32 (4): 556-567.
- Ojiako, U., Chipulu, M., Marshall, A., Ashleigh, M., Maguire, S., Williams, T., and Obokoh, L. 2015. "Heterogeneity and perception congruence of project outcomes." *Production Planning & Control* 26(11): 858-873.
- Ojiako, U., Johnson, J., Chipulu, M. and Marshall, A. 2010. "Unconventional competition–drawing lessons from the military." *Prometheus* 28(4): 327-342.
- Ojiako, U., Maguire, S., and Chipulu, M. 2013. "Thematic elements underlying the delivery of services in high-contact public service encounters." *Production Planning and Control* 24 (6): 532-545.
- Ollus, M., Jansson, K., Karvonen, I., Uoti, M. and Riikonen, H. 2011. "Supporting collaborative project management." *Production Planning & Control* 22(5-6): 538-553.
- Phillips, R., Freeman, R., and Wicks, A. 2003. "What stakeholder theory is not." *Business Ethics Quarterly* 1: 479 - 502.
- Pinto, J., and Winch, G. 2015. "The unsettling of 'settled science:' The past and future of the management of projects." *International Journal of Project Management* 34(2): 237–245.
- Prado, P., and Sapsed, J. 2016. "The anthropophagic organization: How innovations transcend the

- temporary in a project-based organization.” *Organization Studies* 37(12): 1793-1818.
- Quilty, S. 2003. “Achieving recognition as a world class airport through education and training.” *Journal of Air Transportation* 8(1): 3-14.
- Rafferty, A., Jimmieson, N., and Armenakis, A. 2013. “Change readiness: A multilevel review.” *Journal of Management* 39(1): 110-135.
- Ramasesh, R., and Browning, T. 2014. “A conceptual framework for tackling knowable unknown unknowns in project management.” *Journal of Operations Management* 32(4): 190-204.
- Salvador, F., Chandrasekaran, A., and Sohail, T. 2014. “Product configuration, ambidexterity and firm performance in the context of industrial equipment manufacturing.” *Journal of Operations Management* 32(4): 138–153.
- Saounatsos, G. 2009. “Implementation Strategies & Methodologies for ORAT Programs.” *International Airport Review Journal* 6: 26-31.
- Saounatsos, G. 2010. “New Larnaca Airport: Opens Like Clockwork.” *Airports International* 43(1): 34.
- Sariola, R., and Martinsuo, M. 2016. “Enhancing the supplier’s non-contractual project relationships with designers.” *International Journal of Project Management* 34(6): 923–936.
- Shah, R., and Goldstein, S. 2006. “Use of structural equation modeling in operations management research: Looking back and forward.” *Journal of Operations Management* 24(2): 148–169.
- Shay, M., Schools, C., and Co, D. 1991. *Guidelines for Reliability, Confirmatory and Exploratory Factor Analysis*. Race, X, 1–15.
- Shenhar, A.J., Dvir, D., Levy, O. and Maltz, A. 2001. “Project success: a multidimensional strategic concept.” *Long Range Planning* 34(6): 699-725.
- Shokri, A., Waring, T., and Nabhani, F. 2016. “Investigating the readiness of people in manufacturing SMEs to embark on Lean Six Sigma projects: An empirical study in the German manufacturing sector.” *International Journal of Operations & Production Management* 36(8): 850-878.
- Simpson, R. 1998. “Presenteeism, power and organizational change: Long hours as a career barrier and the impact on the working lives of women managers.” *British Journal of Management* 9: 37-50.
- Steele-Johnson, D., Narayan, A., Delgado, K., and Cole, P. 2010. “Pretraining influences and readiness to change dimensions: A focus on static versus dynamic issues.” *Journal of Applied Behavioral Science* 46(2): 245-274.
- Stevens, G. 2013. “Toward a process-based approach of conceptualizing change readiness.” *Journal of Applied Behavioral Science* 49(3): 333–360.
- Svejvig, P., and Andersen, P. 2015. “Rethinking project management: A structured literature review with a critical look at the brave new world.” *International Journal of Project Management* 33(2): 278-290.
- Tabachnick, B., and Fidell, L. 2007. *Using multivariate statistics*. 5th edn. Boston: Allyn & Bacon.
- Takim, R., and Adnan, H. 2008. “Analysis of effectiveness measures of construction project success in Malaysia.” *Asian Social Science* 4: 74–91.
- Trewin, N., Ojiako, U., and Johnson, J. 2010. “Risk management and its practical application: lessons from the British Army.” *Journal of Risk Research* 13(5): 669-686.
- Tucker, A. 2004. The impact of operational failures on hospital nurses and their patients. *Journal of Operations Management* 22(2): 151-169.
- Tucker, A., and Spear, S. 2006. “Operational failures and interruptions in hospital nursing.” *Health Services Research* 41(3): 643-662.
- Tukiainen, S., and Granqvist, N. 2016. “Temporary organizing and institutional change.” *Organization Studies* 37(12): 1819-1840.
- Tysseland, B. 2008. “Life cycle cost based procurement decisions.” *International Journal of Project Management* 26(4): 366–375.
- United States Department of Defense. 2011. *The National Military Strategy of the United States of America*. Pub. Department of Defense.
- Vakola, M. 2013. “Multilevel readiness to organizational change: A conceptual approach.” *Journal of Change Management* 13(1): 96-109.
- Venkatachalam, S., Marshall, A., Ojiako, U., and Chanshi, C. 2019. “Organisational learning in small and medium sized South African energy project organisations.” *Management Research Review*

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- Ventre, K., Barry, J., Davis, D., Baiamonte, V., Wentworth, A., Pietras, M., Coughlin, L., and Barley, G. 2014. "Using in situ simulation to evaluate operational readiness of a children's hospital-based obstetrics unit." *Simulation in Healthcare* 9(2): 102-111.
- Weiner, B., Amick, H., and Lee, S. 2008. "Conceptualization and measurement of organizational readiness for change: A review of the literature in health services research and other fields." *Medical Care Research and Review* 65: 379-436.
- Williams, T. 2008. "How do organizations learn lessons from projects-and do they?." *IEEE Transactions on Engineering Management* 55(2): 248-266.
- Williams, T. 2016. "Identifying success factors in construction projects: A case study." *Project Management Journal* 47(1): 97-112.
- Williams, T. 2017. "The nature of risk in complex projects." *Project Management Journal* 48(4): 55-66.
- Winch, G., and Leiringer, R. 2015. "Owner project capabilities for infrastructure development: A review and development of the 'strong owner' concept." *International Journal of Project Management* 34(2): 271-281.
- Winter, M., Smith, C., Morris, P., and Cicmil, S. 2006. "Directions for future research in project management: The main findings of a UK government-funded research network." *International Journal of Project Management* 24(8): 638-649.
- Wohl, J. 1966. "System operational readiness and equipment dependability." *IEEE Transactions on Reliability* 1(1): 1-6.
- Zeng, S., Ma, H., Lin, H., Zeng, R., and Tam, V. 2015. "Social responsibility of major infrastructure projects in China." *International Journal of Project Management* 33(3): 537-548.
- Zerjav, V., Edkins, A., and Davies, A. 2018. "Project capabilities for operational outcomes in inter-organisational settings: The case of London Heathrow Terminal 2." *International Journal of Project Management* 36(3): 444-459.
- Zimmermann, A., Raisch, S. and Birkinshaw, J. 2015. "How is ambidexterity initiated? The emergent charter definition process." *Organization Science* 26: 1119-1139.
- Zimmermann, A., Raisch, S., and Cardinal, L. 2018. "Managing persistent tensions on the frontline: A configurational perspective on ambidexterity." *Journal of Management Studies* 55 (5): 739-769.
- Zwikael, O., and Smyrk, J. 2012. "A general framework for gauging the performance of Initiatives to enhance organisational value." *British Journal of Management* 23: 6-22.