A Multi-Level Competencies Framework for the Successful Delivery of Major Infrastructure Projects

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Abstract:
Successfully executing major infrastructure projects is economically critical for Governments to build civil infrastructure for sustainable growth of increasingly dense urban areas. In the construction industry, projects continue to fail at an alarming rate. One contextual factor contributing to this alarming failure rate is the lack of competencies to manage increasingly complex major infrastructure projects. Recent literature has explored how “soft” project management practices, such as collaboration, learning and adaptation can enhance project performance. This is in contrast to conventional, or “hard” project management practices, such as control, planning and reducing uncertainty, which are currently used to deliver these types of projects.

In a qualitative study, based on explorative interviews with project managers overseeing major and megaprojects in Australia, we have been able to identify a set of multi-level competencies requisite for this role by considering the key challenges encountered by project managers during the delivery of these complex projects. The findings indicate that behavioural emphasis and "soft" project management skills and competencies are increasingly important.

This paper contributes to the growing literature on examining the development and effectiveness of project managers’ competencies and skills in managing major infrastructure projects in the construction industry. The research presented in this paper should inform researchers in developing empirical studies relating to this important topic area.

Keywords: Major infrastructure projects; project governance, skills and competencies, project manager, project success

1. Introduction

New infrastructure development is becoming increasingly complex which in many ways presents challenges and risks for project managers/leaders. Identifying and dealing with a set of challenges and risks effectively will require new competencies for project management of large infrastructure development projects. Through this research, we explore the challenges faced by project managers in the context of construction and infrastructure development projects in Australia and identify the essential competencies and skills required to overcome these challenges. Our approach to defining project success builds on the widely known iron triangle criteria (Atkinson, 1999). Additional factors for success such as stakeholder satisfaction, current and future impact, and project efficiency, for example are also included.
The new set of competencies and skills are identified by reviewing the literature on the factors that challenge the process of delivering major projects by project managers, and provides a base for understanding the competencies and skills required.

Research has identified two levels of project success: 1) project management success, 2) product success (Baccarini, 1999). The former relates to delivery and the latter relates to the overall outcome of the project. Accordingly, project management success is typically “measured at the end of the project against success criteria, such as internal efficiency, …[and]… typically cost, time, and quality” (Joslin & Müller, 2015, p. 1377). In major infrastructure projects, project management success is not very common. Flyvbjerg (2014) attributed this to issues ranging from complex interfaces involved in major projects to lack of deep domain experience of project managers executing them; and from changing project scope at different stages of its lifecycle to involvement of multiple stakeholders with conflicting interests. Technological and design changes further add to the risk of project management failure, particularly when project managers lack the necessary competencies and skills to effectively leverage such changes. In other words, the lack of competencies and skills to manage the project would risk project success. For this reason, Joslin and Müller (2015) argued that competencies of a project manager are integral to project success.

In this paper, we argue that evaluation of project management success requires a look beyond the conventional criteria for project success. Rather, we need to develop an understanding of an emerging set of risks and challenges associated with project success. Changing technology (and the associated drive to digitize and innovate), and the requirement for new infrastructure to be sustainable and environment friendly, are pushing the boundaries of project management success further. Hence, the need for project managers to upskill in order to remain competent when managing contemporary infrastructure projects.

This necessitates the significance of obtaining an insight into the key challenges faced by project managers in the contemporary infrastructure development environment to ensure they are trained on the right set of skills to develop competencies for successful project delivery. In this paper, we start with an overview of the literature to advance the understanding of the key challenges faced by project managers executing major construction and infrastructure projects. The key themes from the literature in this area were then used to develop a template for interview questions. The interviews were then conducted with experienced project managers to obtain a deeper insight into the nature of challenges faced when delivering major construction projects and the skills used to overcome them. Specifically, this paper reports findings of the interviews of project managers with more than 15 years of experience delivering Victorian infrastructure development projects in Australia to answer the question:

What are they key challenges in major construction projects? And what sort of competencies and skills are required to overcome them to ensure project success in future?

In so doing, this paper contributes to the growing literature on examining the development and effectiveness of project managers’ competencies and skills in managing major infrastructure projects in the construction industry. It is intended that the research presented in this paper will inform both practitioners and researchers on this important topic area.
2. Review of the relevant literature

Understanding of project challenges in construction/infrastructure industry is fundamental to supporting project managers in the acquisition and development of their skillset and behavioral competencies. An in-depth review of the literature focusing on key challenges that affect project managers in large construction and new infrastructural projects is conducted by Ahmad et al. (2019). Their main findings are annotated below.

2.1 Schedule Delays

Many construction projects get delayed, some by a few days only while others are delayed by a year or more. Essentially schedule delays represent “a situation where a construction project does not come to completion within the planned period” (Kaliba, Muya, & Mumba, 2009, p. 524). Research on the causes of delay have attributed these to financial difficulties, not seeking the required approvals on time, changing working conditions, project design, transportation related difficulties, shortage of materials, excessive bureaucracy, coordination problems, and shortage of equipment and tools on site (Ahmed, Azhar, Castillo, & Kappagantula, 2002; Alaghbari et al., 2007; Long et al., 2004). Further, it has been revealed that schedule delays are often complemented by cost overruns.

2.2 Cost Overruns

Major infrastructure projects often make headlines in the public media "for being poorly managed and often over budget” (Ahiaga-Dagbui, Love, Smith, & Ackermann, 2017). Cost overrun is another significant and repetitive problem associated with major construction projects. Cost overrun refers to the increase in the amount of money required to construct a project over and above its original budget (Kaliba et al., 2009). While project cost estimation activities are performed during different stages of the project execution (e.g., planning, tendering, contracting), the initial cost estimates have been found less reliable compared to the estimates obtained during later stages. Poor planning, use of unreliable methods to estimate project costs, modifications made to initial project scope/plan, economic rate of inflation, engineering uncertainties, and use of inexperienced administrative staff are some of the key reasons attributed to cost overruns (Ahmed et al., 2002; Kaliba et al., 2009).

2.3 Poor Coordination

The risk of poor coordination is high in projects involving international collaborations and public-private partnerships. Poor communication among varied groups, bureaucratic relationships and conflicting stakeholders’ interests compound these problems. In the absence of local expertise, construction projects draw requisite expertise from countries with different work cultures, standards, practices and communication preferences thus adding to the project’s complexity and coordination problems.

Similarly, when a large number of contractors and sub-contractors are involved in a project, the relationships between the parties involved as well as the transfer of information between them becomes complicated. This further adds to coordination problems and also increase the risk of disputes between the parties, particularly in instances where their communication means were ineffective (Long et al., 2004).
2.4 Contractual Problems

Whilst a fair and transparent bidding process and pre-qualification of tenders ensure that the tenders are given to competent contractors, selection of inexperienced contractors and sub-contractors and mis-managed contracts with them cause contractual problems (Long, 2004). Moreover, inefficient contractors can negatively affect the work of other parties involved in the project.

2.5 Inadequate Assessment and Project management of Project Risks

Project risk, defined as an uncertain event that affects the achievement of project objectives, needs to be closely monitored and carefully managed to successfully deliver large construction projects. In the view of Nketekete, Emuze, and Smallwood (2016), the risks could be internal (e.g., design issues, labor disputes) or external (e.g., natural hazards, political changes) to the project.

2.6 Poor Stakeholder Project management

Stakeholder project management is a recognised approach for building strong and positive relationships with the project’s stakeholders (Mok et al., 2015). Since major infrastructure projects are likely to involve a large and diverse group of stakeholders with varied interests in the project, project managers can face stakeholder project management associated challenges. For example, in terms of identifying the groups, their specific needs, and their impact on the project. For example, a mega construction project in China was delayed by a year due to a legal dispute relating to the project’s ecological impact with a stakeholder group. (Mok et al., 2015). Biesenthal, Clegg, Mahalingam, and Sankaran (2018) similarly consider public and media scrutiny as an “Arena of Controversy” in the megaprojects area. When megaprojects are open to public eye, success criteria become misrepresented, power and politics affect project management, and external agencies distort priorities (Patanakul et al., 2016).

2.7 Conflict Project management

Given the project’s complexity and involvement of diverse group of stakeholders, there is a potential that the project may influence the community life and people’s relationships in negative ways. This results in conflicts. Poorly managed conflicts contribute to delays in project completion and cost overruns, and may invoke litigation proceedings (Long et al., 2004).

2.8 Poorly Managed Change Processes

The infrastructure sector is currently experiencing a speed of change significantly faster than it has ever seen before (Heunis, 2016). Major construction projects are often associated with a range of changes from project scope to design, that occur somewhere between their initial planning to final implementation stages. A poorly managed change process can severely disrupt project success. An important category of change is associated with technology. In fact, technology is a major driver of change in infrastructure industry. Current trends towards digitization provide a major source of change. For example, Building Information Modelling is transforming many processes involved in executing the project. Likewise, semi-autonomous construction equipment has automated many jobs that were previously done manually during the construction process.
2.9 Building Information Modelling (BIM)

BIM has been defined as “a set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building’s life-cycle” (Bryde, Broquetas, and Volm, 2013, p.). Through its holistic nature, it allows for the electronic input of information and geometric modelling, as well as other processes that enhance project management success (Bryde et al., 2013). It can be used to improve stakeholder collaboration and reduce the required documentation time, hence ensuring a project’s success (Bryde et al., 2013).

Another challenge exists with the emergence of ICT, whereby new technologies often have difficulty fitting within current practices (Froese, 2010). It has been suggested that the reason for this is that current practice in project management de-emphasizes the interdependencies between tasks, whereas the emerging technologies are aimed at collaboration and integration of tasks (Froese, 2010).

2.10 Big Data

The infrastructure industry generates massive amounts of data given its growing use of technology (e.g., BIM). This is termed as Big Data, defined as “the ability to process large amounts of data and to extract useful insights from data” has a growing application in the construction industry (Bilal et al., 2016, p. 500). The growing use of technology is also associated with challenges. For example, research by Jacobsson and Linderoth (2010) on the utilization of digitized survey showed: “The construction workers’ representative complained at a number of production meetings that the workers needed the survey measures for the progress of the work. On one occasion the digitized survey was even blamed for the workers not getting enough drawings, even though the architect’s firm was responsible for the heavy delays in their delivery” (p. 18-19).

In view of the technological disruption, the future of project management success remains uncertain unless project managers are competent with the use of new technologies.

2.11 The New Agenda of Sustainability

Sustainability is considered as an emerging dimension of project success (Moehler, Hope, & Algeo, 2018; Hope & Moehler, 2014; Alvarez-Dionisi, Turner, & Mittra, 2016; Buehler, Buffet, & Castagnino, 2018). According to the “triple bottom line” concept developed by Visser & Elkington (1999), sustainability is about aligning economic, environmental and social aspects with a set of sustainability principles. Since the industry consumes a large percentage (up to 50%) of non-renewable resources (Willmott Dixon, 2010; Ametepey & Kwame, 2014). According to Guo et al. (2014), “The construction site and construction wastes of large infrastructure projects, particularly road and tunnel projects, are likely to impose environmental and associated social impacts. Environment-related effects on surrounding livelihoods and the ecological and urban systems can be a delicate issue to deal with” (p. 817). Moreover, rapid urbanization and the steady wave of technological change in the construction industry are associated with disruption and unsustainability of the natural environment.

Accordingly, project managers need to be conscientious of the environmental impact of the resource used. Project management success now requires sustainable development practices (Hope & Moehler, 2014). Individual standards related to sustainability practices such as Green
Project Management Certifications have been developed to fill this gap in project managers’ competency domain (Alvarez-Dionisi, Turner, & Mittra, 2016).

Further, in terms of sustainability, project managers should carefully consider their procurement options and utilize those types of materials that are associated with ecological benefits rather than ecological costs.

2.12 Tackling Unethical Behaviour in the Industry

Research highlights a bad reputation of architects, quantity surveyors and contractors in the industry when it comes to ethical conduct (see also, Bowen, Akintoye, Pearl, and Edwards, 2007). Bowen et al. noted a range of prevailing unethical behavioral problems such as corruption, bribery, fraud deceit, misinformation and dishonesty in the South African industry. According to these authors, the industry “suffers from unfair tendering practices, as well as over-claiming and/or withholding payment for service delivery” (p. 631).

Project management success requires effective tackling of such unethical conduct. Ethical procurement has been described as an approach “to ensure that products are purchased from supply chains that have undertaken ethical trade” (Mustow, 2006, p. 13). This highlights that project managers should procure all construction material in a responsible manner thus developing ethically sustainable capabilities to ensure ethical procurement of materials throughout the construction industry’s supply chain. For example, the UK industry conforms to the ‘Green Guide to Specification’ for the procurement of construction materials. This guide allows “specifiers of construction products to assess the level of environmental impact of those products” (Mustow, 2006, p. 14).

2.13 Corporate Social Responsibility

The notion of the corporate social responsibility becomes relevant from the sustainability perspective of the industry as we consider the potential damaging effects of construction activities on the natural environment. Corporate Social Responsibility (CSR) has been defined as “corporate policies and actions that go beyond the organization's economic interest and aim to affect stakeholders positively” (Ng, Yam, & Aguinis, 2018, p. 2). The construction industry has been associated with the depletion of natural resources (Mustow, 2006), which mandates the industry’s need to incorporate CSR initiatives in the form of environmental protection and community building. Ulutaş Duman, Giritli, and McDermott (2016) argue that “many companies in this industry are having difficulties in integrating their social, ethical and environmental concerns into their operations and stakeholder interactions” (p. 219).

2.14 Occupation Health and Safety (OH&S)

When it comes to OH&S, the construction industry has a questionable record, perhaps because working on a construction site is not considered as safe as working in an office environment. For this reason, Fang, Chen, and Wong (2006) have termed the construction industry as the “dangerous industry”. However, the growing application of technology is now making the nature of construction work and construction jobs safer. Technology can also make it more convenient for workers to adhere to safety standards.
3. **Overcoming the challenges**

The challenges facing project managers in the construction industry has far reaching consequences requiring the development of new and enhanced competencies and skills to support the successful delivery of projects.

Project management bodies and associations have set out competency frameworks for the project managers involved, which emphasize both hard and soft skills. By applying a balanced combination of competency and skills, project managers can overcome the challenges associated with projects. Takey and de Carvalho (2015, p. 785) defined competence as the “ability to mobilize, integrate and transfer knowledge, skills and resources to reach or surpass the configured performance in work assignments, adding economic and social value to the organization and the individual”. The competencies relate to both personal (e.g. leadership; communication style, teamwork skills) and technical aspects.

The foregoing overview of the literature implies that successful delivery of large construction projects is not an easy task. We need to understand how project managers respond and react to these varied challenges. The aforementioned literature review sets a foundation to understand the key challenges in delivering major construction projects through answering the research question of what sort of competencies and skills are required to ensure future project success.

4. **Method**

This paper is part of a study that examines the key challenges faced in the delivery of major projects to advance knowledge on competencies for project success. From this project, one paper (i.e. Ahmad et al., 2019) is centered around a review of the literature whereas the present paper focuses on the challenges and competencies of project managers in the context of Victorian infrastructure development projects in Australia. Focusing on the qualitative analysis of explorative interviews, this article explores both the probing for initial relevance and emerging themes. Accordingly, we conducted, at the time of submitting this paper, two face to face interviews with experienced project managers working in the context of Victorian construction industry to obtain a clear picture of the challenges and project managers’ responses to these challenges. Each interview lasted from 35 minutes to 1 hour in duration. Our interviewees comprised both male and female participants who have obtained a Master’s Degree in Project management. On average, they had above 16.5 years of project management experience, which involved at least 10 major construction projects. The core themes from the literature review (e.g. technology, sustainability, OH&S and risk project management) were used to develop the interview questions.

The interviewees were provided with a copy of the explanatory statement together with a consent form to complete. The interviews were digitally recorded, transcribed in verbatim and the digital transcripts were subjected to template analysis of the data. Template analysis is an approach that involves thematic analysis of qualitative data such as interviews. The analysis involved developing a coding scheme or a template, which contains themes that were identified on the basis of the literature and organized in a structured manner (King, 2012). Specifically, we applied a hierarchical coding scheme based on dual focus of our research: challenges and competencies, forming the overarching themes in the hierarchy. The literature suggests that
emerging challenges relate to change (i.e. scope and schedule related), technology, sustainability, stakeholder project management, risk project management and OH&S when executing project delivery in this increasingly complex environment. This was followed by questions on the competencies and skills requirements to overcome such challenges.

5. Findings

At the beginning of the interviews, we requested the project managers (herein reported as Project Manager A and Project Manager B) to report the extent to which selected themes (see Table 1) have challenged them on a scale ranging from not at all, to moderate to high. Table 1 presents their responses. This was followed by questions requesting in-depth answers relating to the study’s core themes that were subjected to template analysis.

Table 1. Structured responses from interviewees

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Degree (A)</th>
<th>Degree (B)</th>
<th>Challenges</th>
<th>Degree (A)</th>
<th>Degree (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule Delays</td>
<td>High</td>
<td>M to High</td>
<td>Coordination problems</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Cost concerns/Financial</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Communication problems</td>
<td>Not at all</td>
<td>Not at all</td>
</tr>
<tr>
<td>problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scope Changes</td>
<td>High</td>
<td>High</td>
<td>OH&amp;S issues</td>
<td>Not at all</td>
<td>Moderate</td>
</tr>
<tr>
<td>Conflict</td>
<td>Not at all</td>
<td>Moderate</td>
<td>Procurement issues</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Labour Issues</td>
<td>Not at all</td>
<td>Moderate</td>
<td>Technology</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Managing stakeholders'</td>
<td>Moderate</td>
<td>High</td>
<td>Environment</td>
<td>Not at all</td>
<td>Moderate</td>
</tr>
<tr>
<td>Expectations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contractual problems</td>
<td>Not at all</td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 demonstrates that schedule delays, scope changes, managing stakeholders, their coordination, and technology appeared to be of moderate to high concern for project managers in Victoria. The rest of the interview questions were structured around the core themes as discussed earlier. With the hierarchical coding scheme for data analysis, the results are reported in two major themes: 1) key challenges faced by project managers of major infrastructure projects and 2) key competencies required for a project manager.

5.1 Key Challenges

The findings of the key challenges follow the research template that was used to structure the interviews and the analysis of project managers’ answers revealed themes as reported below:
5.1.1 Changing Schedule and Scope

Changing schedule and scope was recognized as a highly challenging issue by project managers particularly as more and more projects are executed in a live environment, with clients expecting a quick delivery. According to Project Manager A, “Scope changes I'm seeing more of a trend now particularly as projects get funded and often there is a couple of years [gap] before it is delivered and finished. Technology changes and clients needs change, so there are always going to be scope changes”. Similarly, Project Manager B also discussed scope as a challenge: “I think also the other significant problem is one of understanding what you’re doing and the scope and the objectives being clear before you begin”.

5.1.2 Technology

Technology appeared as another highly emerging challenge faced by project managers as the notion of technology usage varied across the project team members, from routine administrative tasks such as document storage to more complex activities of project design and development (e.g., BIM): “As a project manager one of the biggest tools we use in technology is your kind of platform based knowledge sharing like an Aconnex I think that's kind of the industry standard these days” (Project Manager A).

BIM is another commonly deployed software application in infrastructure projects. However, Manager B disclosed that BIM poses some challenges to project managers: “It’s another thing that we haven’t really got our mind around and BIM is the classic, no one really know what they mean when they ask for BIM. So, it can be as much a problem as solution”.

Information overload was identified as another key challenge associated with technology: “There is so much information available and everything that it can sometimes distract you from what you are trying to do as a project manager and often you find that PM’s coming from a far more technical background will love those sort of things because they'll delve into the detail but I think one of the challenges is really pulling yourself back out of that detail and working at that project still as a whole of project approach and not getting weighed down by the information that's available” (Project Manager A).

Finally, participants acknowledged that the Victorian government is spending billions of dollars on infrastructure development. Yet presence of a robust digital engineering framework is still a challenge in this context, which is required for a robust execution of major projects: “You get everyone in a room and no one can agree on what that [digital engineering framework] looks like. Even at the framework level beyond the, well so what do we expect from the project participants then so the engineers, the contractors the operations maintenance people, the ITS around that and how does that all connect is a real challenge right now” (Project Manager B).

This shows that a technological challenge may relate to developing a coordinated understanding its use.
5.1.3 Sustainability

In the project managers’ experience of the government’s projects, they found sustainability is a highly prioritized issue: “Certainly over the last decade I think sustainability has certainly become more of a norm I think that kind of 10 years ago it was a nice to have you needed to demonstrate that you were sort of looking at it it’s now very much entrenched in how you deliver projects”. Yet, they disclosed that the notion of environmental sustainability itself challenges project managers: they should “Know what are your materials doing, what are you using and what’s recyclable, how can we engage with different marginalised groups, how can we design buildings that are going to be more inclusive of people” (Project Manager A).

The interviewees shared that CSR is making the Victorian infrastructure projects more complex: “So at the moment on our large project we’ve just finished the first draft on the environmental effects statement which covers not just flora and fauna as the most basic I guess but subsurface water and hydrogeology and cultural and human factors and business impacts they’re all a part of it” (Project Manager B).

5.1.4 Stakeholder Project management

Stakeholder project management was an apparent challenge for project managers given the diversity of the stakeholder groups involved:

“Because we work in infrastructure development, our stakeholders are always the same and they are everybody. So going through a process of understanding who the key ones are and who the drivers are and how we manage them individually or specifically is a key [challenge]” (Project Manager B).

Good communication strategy appeared to be critical for an effective stakeholder project management: “I think sometimes that is part of our job is having those tough conversations with your stakeholders and there is no substitute for sitting in front of someone. I think written communication is really important for decisions so talk to them first and then follow it up in writing because if you pair everything back you are still contracted to do a job and there are contractual implications of decisions and they need to be tracked” (Project Manager A).

5.1.5 Risk Project management

The implementation of risk project management strategy was identified as a challenge that can affect the successful delivery of major infrastructure projects. Project Manager B suggested the following approach to risk project management: “We’ll have multiple risk registers that will be updated ADHOC and infrequently, and then also I think that typically we’re pretty poor at taking what we’ve learnt from any risk review... don’t see many instances where project managers pour through their risk register and update their risk project management plan or their control in response to that”

Further in the Victorian industry context, Project Manager B shared that risk project management is “poorly done as a discipline”, despite regular dedicated risk workshops, “the outcomes from them are pretty static”.
5.1.6 OH&S

Keeping herself and her people up-to-date with the changes in OH&S domain was recognized as “one of the biggest challenges” and “something that is continually evolving in terms of safety onsite” by Project Manager A who shared her challenging experience as follows: “I worked on Margaret Court Arena [a major tennis court] for instance and we had a real safety issue after it opened where the glass in one of the big house lights shattered because of heat loading and so then you need to then go well my builder is not on site anymore or they are or what do I need to do and how do I make it safe for the people who are now frequenting this venue because it's still sits with you”.

5.1.7 Other Challenges:

Resources: This was recognized as a challenge because “Resourcing: it is having the right person at the right time available” (Project Manager B).

Financing Issues: Although project are constrained by budgets sometimes, in terms of financial issues, Project Manager B considered “Budget concerns tend to be more an outcome of other issues and challenges more so”.

Conflict: In terms of conflict, labour was considered as particularly challenging “in terms of probability and capacity”.

5.1.8 Key Skills and Competencies

Whilst discussing the key challenges, project managers also shared their views on skills and competencies required to offset such challenges. In the following, we report the findings in the light of core themes discussed earlier.

5.1.9 Managing Changes in Schedule and Scope

This would require proactive thinking from project managers in terms of educating the client at the start that things are likely to change during project execution: “From both their perspective and from the design perspective and what that means to your end result and your finances and obviously your schedule with scope changes”. For this reason, project managers need to engage in contingency planning and plan for change. Success to this end is “about managing your stakeholder expectations that if you want more it takes more time or if you want to deliver it with no shutdowns that it's going to take more time so for me success is about in terms of schedules sitting your client down having a difficult conversation with them and agreeing a new schedule” (Project Manager A).

A successful changes process is conducive to flexible approach, quick adaptability and agility of project managers.

5.2.2 Managing Technology

In our interviewee’s view, managing the technology would require able project managers with knowledge and analytical skills as new technologies are fast emerging. In their view,
successful projects rely on a good project manager who can define the requirements and make sure those technologies meet that and then take the project on the journey to deliver on it.

Specifically, in terms of skills, Project Manager A emphasized: “Obviously the computer skills side of things is huge. The other thing I think is there needs to be an analytical side of what you're doing because this information is being produced by one party you know on a project you need to be able to analyse what information is coming at you and decide whether this is in fact a) What we are wanting for the project and b) whether it's really being driven by sort of an objective that one part of the project team is trying to meet and whether that meets with the objective of the whole of project”.

Project Manager B shared similar thought: “New technologies that are emerging and advancing and the ability to stop and check and assure that that actually meets the projects requirements is really important”. But he reflected on project managers’ skills beyond technical skills: “What I’m interested in is you showing me that you understand the project, then we’ll make sure that what we use to manage it aligns with that. So managing for the context of the project not the basis of the technology. Because these technologies are emerging so fast outside [the project environment]”.

5.2.3 Managing Sustainability

Both project managers acknowledged the environmental challenges as many of their projects bear a significant impact on the environment, particularly in terms of energy and consumption of other resources. So they considered having a deep understanding of sustainability associated challenges particularly in terms of the ethical implications relating to the resource use. For sustainability project management, Project Manager B advocated “having an environmental team as part of our business certainly helps. We can turn to the contaminated land guy and ask a question...”

5.2.4 Managing Stakeholders

As project managers work with a diverse group of stakeholders, they emphasized on high-quality communication skills and showing empathy. Empathy is important to understand your stakeholders and their needs: “I think the first step in any stakeholder project management is actually looking at who you are talking to it's about going into the business and learning about what their day looks like and what their daily life looks like because that will impact how they are able to engage with you on a project.” Similarly, good communication skills are required as communication is important to engage with them: “how I communicate with them [stakeholders], my view is always sitting in front of them is going to be the best way of getting to know your stakeholders” (Project Manager B)

With their communication skills, project managers can keep the stakeholders engaged “because often project management don't see the intricacies of the challenges that have led to getting this project up” (Project Manager B). They can also tailor the information shared to make it more effective.
The analysis of interviews also highlights the optimal frequency of communication with stakeholders: “I think if you aren't talking to your stakeholders in a 2-week period. They get nervous I think that you have your structured you know fortnightly or when meeting but you might have some informal catch ups on a weekly basis with your key clients”. This is because to project managers’ silence may imply things are going well, “but for them this makes them feel a bit unsteady about what decisions are being made without them” (Project Manager B). Thus, frequent casual communication along with formal communication is important.

5.2.5 Managing Risk

The interview analysis revealed that running a risk workshop with the project’s design team, contractors and clients during initial stages of project development is an important approach to manage risk: “That's your first step to identifying the big stuff, but also making risk a conversation that isn't a scary one often risk involves actually interfacing with different project partners. It's not just about safety risks, it's about what's the risk our design team doesn't perform” (Project Manager A). According to Project Manager B, although major projects generally involve a dedicated risk project management team, project risk project management could still be an intuitive process: “we have a dedicated risk project management team but we don’t use them well enough, and as much as anything it’s a cost thing, and a intuitive, optimistic or biased thing that I as a project manager have my risk register then I will manage that and the metrics around it, the data around it.”

5.2.6 Managing OH&S

Project managers are obligated to design and deliver projects that are safe. In terms of OH&S, the analysis of interviews highlights that project managers should be knowledgeable of their obligations under OH&S, and ensure that the associated risk is sitting with the right party: “I think that is sometimes forgotten, you need to make sure as a project manager you are assigning risk to who should actually be controlling it and that is particularly true on safety as you don't want to be taking that on”. (Project Manager A).

However, Project Manager B shared that “people who are trained in occupational health and safety and their view of the world is sometimes difficult to manage as a project manager. So you’ve got to make decisions around level of risk that you accept for yourself or for your client... Safety analysis and their safe work methods and all those things and inspections and they’re all static things but you’ll have a guy out there who is doing some work, and he’s got his back to an excavator, and he may or may not get injured but that behaviour is at risk”. In this situation, he shared the behavioural protocol that is followed in the Victorian projects’ context, whereby leaders visit the site with their site project managers, project project managers and project directors:

“We’ll go out and we’ll do an observation piece and we just watch the workplace happen. And we’ll tick off the type of activity we’re watching and whether the behaviour of the person or the team was a risky behaviour or not. And then we’ll take that and have a conversation with them and one we did there was a guy working with an excavator moving a big chunk of asphalt that had just been dug out of the road. The guy had his hands down near
the asphalt and the excavator was moving those things and we must said why did you continue to work when you knew the excavator was doing stuff and his answer was well I trust the guy in the excavator cause I’ve worked with him for four years and I could see and I had gloves on. So it’s about having the conversation around [such risky] behaviours.”

In closing, we ask our interviewees about the competencies and skills required of an effective project manager in this infrastructure space and the behaviours that are associated with those skills. In Project Manager A’s view: “one of the most important skills is being able to step away from the technology and still engage on a human level with project partners”. Whereas in Manager B’s view “the answer is there isn’t one. It’s everything, and I think that’s the thing. I think it’s one of taking responsibility for the delivery of the project and its outcomes and everything underneath that.” He added: “I guess this is the behaviours, to get organised, to plan, manage and control…. There’s a whole bunch of underlying skills and techniques and tools to do that. So the skill is to know which one to use at which time which means the skill is really understanding what is important in your project”.

6. Discussion

Major infrastructure projects are the delivery vehicle for the development, expansion and extension of Governmental investment that is intent in place making. Whilst a successful engine for change, major projects have been under scrutiny for their poor success record, attributed to challenges associated with technological disruption, changing requirements and scope of the project, mis-management of project’s risk and stakeholders’ concerns in addition to a host of sustainability-related issues. This paper explores multi-level competencies for project success in the context of major infrastructure development projects in Australia through an exploratory qualitative inquiry based on experienced project managers’ views of key challenges encountered and the requisite competencies and skills to offset the same.

The participating project managers shared their varied views on project success: 1) project success is about managing the stakeholders’ expectations, 2) establishing clear communication with the client on appropriate level of contingency planning for change, and 3) the client or project owner gets what they needed out of the project. This highlights the complexities in defining the notion of project success (Joslin & Müller, 2015; Koops, Bosch-Rekveldt, Coman, Hertogh, & Bakker, 2016; Radujković & Sjekavica, 2017). To quote Manager B: “Successful projects rely on a good project manager who can define the requirements and make sure those technologies meet that and then take the project on the journey to deliver on it”

Indeed, major projects are complex entities involving a complex array of activities which shape the notion of success. In meeting the criteria of project success in major infrastructure projects, project managers confront numerous challenges. They are challenged by their schedule constraints, budget, their community’s concern to protect the environment and conserve resources, their workers’ concern to ensure safe jobs and injury free work sites, and
their limited information processing capabilities in the age of big data and BIM tools (Ahmad et al., 2019; Alaghbari, Razali A. Kadir, Salim, & Ernawati, 2007; Long, Ogunlana, Quang, & Lam, 2004; Mok, Shen, & Yang, 2015).

The rapid adoption of ICT and other sophisticated technological tools and applications poses a major challenge for project managers to be competent in digital skills. Given the long duration of major projects, technological advancements imply that the technology in-use could get outdated soon. This requires project managers to exhibit quick on-the-job learning and adaptability (Heunis, 2016). Thus, a key to sustainable project development may lie in reshaping their technological competencies and skills: “I see that as future generations are coming through our reliance on technology for communication tools is so heavy you know already you see younger project managers you talk to them you say, have you spoken to the clients about that and they say yep yep yep and you go what did you actually do and they go are we sent an email or we sent a text message so I think the challenge and the skills they need to have is being able to step away from your phone or your computer and have a conversation with somebody and I think that is going to get lost and it’s going to have to be a conscious thing that we are making sure the project managers are still doing because it is a human based thing whatever you are doing” (Project Manager A).

This highlights that project managers need to develop skills in communication and empathy.

Similarly, in the construction industry context of Australia, the preservation of the natural environment during project execution is a key. Construction activities should be performed in a manner that minimizes their environmental impact and safety risks. Accordingly, project success requires proper consideration of environmental issues by considering the ethical implications of the resources used. This may require training on ethics.
The findings also highlight the important of strong leadership skills, particularly to manage the critical aspects of health and safety in the project environment. For example, the experience of Manager B clearly showed that OH&S management is not about having policies in place and ticking against them, but rather active vigilance of the environment and deep conversations around potential risky behaviours to determine the level of expertise and level trust among workers undertaking risky tasks. This shows the importance of leadership qualities of project managers and their ability to bring the best out in their team.

7. Conclusion

The increasing complexity of managing large construction and infrastructure development projects in Australia presents a variety of emerging challenges for project managers/leaders. It is therefore not surprising that project managers require a new level of competencies and skill sets to remain competent for successful project delivery. To identify these new competencies and skills an extensive review of major projects from the project management literature was conducted. From the extent literature, 14 challenges were identified. These challenges ranged from the standard challenges that have plagued project managers for years: schedule delays caused by a variety of issues; poor coordination from poor communication, cost overruns, contractual problems, poor stakeholder management and conflict management for example.
However, several new challenges emerged, such as the emergence of ICT where new technologies had difficulty fitting into current practices, the use and ability to process big data, sustainability, and corporate social responsibility. To understand how project managers respond and react to these key challenges, exploratory research was conducted using a qualitative data approach. From the literature, a set of key themes provided the base to develop a template for a set of interview questions. Interviews were conducted with project managers to obtain a deeper insight into the nature of the new challenges.

From the interviews two major themes were identified: key challenges and key competencies faced by project managers of major infrastructure projects. It can be seen from these challenges and competencies that managing major infrastructure projects involve major complexity. Project managers are challenged by schedule delays, scope changes, cost concerns, managing stakeholders’ expectations, coordination problems, procurement issues and technology. It is argued that these challenges and competencies have a role in determining project success.

References


