

BMPF7101: Qualitative Research Assignment

The key in-depth professional and personal insights, experiences and lessons gained by external consultants during the implementation of the IT, Data and Digital Technology programme within an infrastructure mega-project.

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Abstract

Purpose: The purpose of this research study is to understand the key in-depth professional and personal insights, experiences and lessons gained by external consultants designing and delivering the IT, Data and Digital Technology programme (ITD&DT) for a Tier 1 Joint Venture (JV) delivering a large part of the biggest infrastructure mega-project in Europe.

Context: Industry background on the current and future use of information and digital technology in construction is provided, together with a description of the context and scope of the ITD&DT programme and its contribution to the mega-project JV.

Method: The researcher adopted an Interpretivist research philosophy, applying an Inductive Phenomenological approach to a case study scenario, using a mono-method, cross-sectional time-horizon and three in-depth un-structured interviews with consultants who designed and delivered the end-to-end ITD&DT. Thematic Analysis was used to identify meaning, overall themes and lessons. The use of non-intrusive interviewing enabled interviewees to think and speak freely about the experiences and lessons they viewed as most significant.

Findings: The Themes and Lessons reflect the real-life experiences of the interviewees, and each Lesson is positioned against the observed context of the interviewees, where the experience or Lesson was shared. The Themes are: Strategic Direction, Planning and Governance; Leadership and Sponsorship; Organisational Culture and Competency; Procurement and Commercial; Data Integration and Technology; Project Management and Delivery and Continuous Improvement.

The study identifies potential gaps in the literature and offers insight and practical guidance for those involved in the strategy and delivery of ITD&DT in infrastructure mega-projects and associated JVs.

Key Words: Infrastructure, Mega-project, Construction, Joint Venture, IT, Data, Insights, Digital Technology, Interpretivism, Case Study, Qualitative.

Introduction

The construction industry is undergoing a transformation in its use of information and digital technology (IT) but lags other sectors in the adoption and optimisation of modern IT, and in leveraging data in strategic, structured, and integrated ways for informed insights and decision-making. This historical context and culture present significant challenges when designing and implementing large-scale IT, as the gap between modern practices and traditional mindsets and capabilities are bridged.

Iriarte and Bayona (2020 p.51), suggest “that IT, projects and programmes serve as vehicles of transformation and business growth.” Defining success in IT projects is challenging, and Davis (2014 p.190) recognises this is based on the perception of individual stakeholders and the extent to which their own objectives are achieved. Iriarte and Bayona (2020 p.51) conclude that the success of IT projects is “a multi-dimensional concept depending on criteria, stakeholder perception, the context and the phase the project is found.”

Barbosa et al. (2017) recognise that Construction lags other sectors in integrating digital technology, but that mega-projects are more advanced in digitising operations when compared with the general Construction sector. Koeleman et al. (2019, p.2) indicates that digital transformation can deliver productivity gains of 14%-15% and efficiencies of 4%-6%, however, only “16% of respondents said their organisations' digital transformation had delivered sustainable performance improvements”.

Digital transformation involves change and innovation of business models and operational processes, and success is determined by how effectively processes and working practices are changed and enabled by the new technologies. Koeleman et al. (2019, p.3) recognise this is challenging, as projects are fragmented, as the value chain is made up of technical specialists from contractors and sub-contractors, who tend to work in technical silos. This results in a transient team and an environment which is highly federated, complex, and adversarial, because of the nature of construction contracts.

The implementation of digital IT is challenging, as it requires integration across multiple organisations and teams which have their own culture and digital solutions. This is even more complex in mega-project joint ventures (JVs), where parent organisations must learn to work with each other despite competing interests, culture, business models, operational processes and practices, and differing sub-scale digital, IT strategies and systems.

Infrastructure and construction mega-projects, due to their scale and relative independence from parent organisations, have the opportunity to define a clear and

progressive strategy and culture for IT which enables transformed operational efficiency, productivity and effective construction delivery.

Purpose and Aims

The broad purpose of this qualitative case study research is to explore the most significant, real-life lessons and experiences of external consultants through their work on the IT, Data and Digital Technology (ITD&DT) programme within an infrastructure mega-project JV.

It is important the reader is aware that the Researcher who conducted the interviews, was previously a consultant working within the mega-project JV for four years and was as involved in the ITD&DT programme and real-life situation, as the interviewees. The Researcher recognised this conflict of interest, potential ethical challenges of bias and influence and the need to achieve authentic high-quality data. The research approach has therefore been designed in such a way as to remove or minimise these issues. The approach is described in detail in the Approach to the Research section.

Context

The mega-project forming the context for this research, operates within an environment of competing demands and challenges. It is characterised by its scale, technical engineering, organisational complexity, high-cost, and multi-faceted nature of the physical environments in which infrastructure is being built. Leadership and management demands include continuous navigation of evolving challenges, uncertain economic conditions, frequent political intervention, public scrutiny and extensive stakeholder engagement with the client organisation, communities, sub-contractors and consenting bodies. Each party has a distinct set of requirements which must be effectively managed, compounding accountability and performance pressures.

An unfavourable and uncertain economic environment has increased costs, resource pressures and commercial and contractual complexity. At the core of the mega-project lies the technical and organisational complexity of designing, achieving consent for and constructing infrastructure assets, whilst adhering to rigorous technical, environmental and safety standards. All these factors impacted the mega-project's progress against baseline plans and budgets.

The external consultants held the sub-contract for the delivery of an end-to-end, fully comprehensive programme supporting the ITD&DT needs of the JV. This greenfield

programme involved the development and implementation of an enterprise scale best-of-breed, cloud-based IT strategy covering; operational and security frameworks; related operations; intricate IT service and facilities plans, including remote connectivity; IT infrastructure, devices and software; the selection and implementation of critical business systems; exit and data management and insight strategies and technology innovations, including data-driven insights and Artificial Intelligence (AI) to improve decision making and optimise the effectiveness and efficiency of operations.

Due to initial cost and resource underestimations by the JV, consultants assumed responsibility for budgetary control and the development and management of financial models to ensure full alignment with the mega-project's objectives. They also fulfilled the leading role in procuring technologies, shaping of contractual commercial agreements, governance processes and ensuring compliance with the JV's strategic goals. The consultants provided expertise to the JV and JV's client in aligning the IT strategy with the broader goals of the infrastructure mega-project, emphasising a cloud-first, best-of-breed approach, enabling digital transformation and innovation.

To achieve this, consultants addressed significant competency gaps within the JV, taking responsibility for identifying and defining technical and functional requirements, engaging with relevant stakeholders to ensure solutions were delivered that were technically robust and aligned with the JV's and JV's client's expectations.

Approach to the Research

Introduction

This section systematically explores the research philosophy, strategy, methods, time horizon and techniques, participant selection, data collection and analysis adopted by the researcher to achieve academic robustness.

Research Philosophy

Interpretivism is the underpinning philosophy of this research. It is socially constructed and focuses on how individuals view their world and the meanings they give to their experiences (Cresswell (2007). This approach is complemented by Phenomenology, which aims to achieve a deeper exploration of participants' lived experiences (Hein, and Austin (2001). This philosophical foundation to the study allows the researcher to have insight into and to prioritise interviewees' perspectives, ensuring they shape understanding of the lessons learned and experiences gained.

Research Strategy and Approach

The research strategy is a single-site case study focusing on the infrastructure mega-project with the aim of understanding the lessons and experiences of the external consultants who delivered the IT programme. The use of a case study is effective, as it provides contextual insight and fits well with Interpretivist and Phenomenological approaches.

Method Choice

A mono-method qualitative approach using unstructured interviews was selected, as this aligns with Interpretivist and Phenomenological philosophy and provides participants the flexibility to freely articulate their experiences. Barret and Twycross (2028, p.63) recognise that qualitative interviews give the most direct and straightforward approach to gathering detailed and rich data regarding a particular phenomenon. The researcher designed an approach which allowed conversational dynamics to evolve naturally, aiming to capture the interviewees' real-life experiences and related lessons during their work on the programme (Atkinson, 2002, p.125) cited in Brinkmann (2022, p.437).

Research Time Horizon

The research uses a cross-sectional time horizon, to capture interviewees' reflections on past and current lessons and experiences, enabling analysis of the immediate and enduring impacts within the context of the ITD&DT's implementation.

Participant Selection

Interviewees were external consultants, all with over seven years' experience working in the JV and were selected using convenience sampling due to their ease of involvement, accessibility and availability. The researcher was mindful of the potential lack of representativeness, limited generalisability, and potential risk of bias of this sample and case study (Tsang, 2014). The sample included individuals holding critical ITD&DT roles covering programme, technology, cyber security, system architecture, and infrastructure consulting. The interviewees' highly relevant involvement in and insights into the programme, and their depth of professionalism enriched the data collected, providing a range of the representative perspectives. The researcher encouraged a focus on depth and quality of insights. Participants were volunteers, and each signed a Participant Agreement Form in advance. This provided the title and a description of the research focus

and advised that interviewees could withdraw at any time. Indeed, one interviewee withdrew and was replaced at short notice, due to bereavement.

Ethical Considerations, Data Collection and Write-up

Ethical considerations were intrinsic to the research's design, execution, and analysis. The UWTSD standard Application for Ethical Approval including a copy of the Participant Agreement Form and Risk Assessment was submitted and approval gained, prior to data collection. The ethical process considered multi-dimensional safeguards including avoidance of conflict of interest and bias, informed consent, anonymity, confidentiality, and the interviewee's right to withdraw at any time.

Data was collected via unstructured interview, lasting 40-45 minutes, each conducted by the researcher using UWTSD's Microsoft Teams to video record and transcribe the interviews, ensuring high-quality and secure storage.

In preparation for each interview, the Researcher held a 20-minute telephone call with each interviewee during which he explained in appropriate detail, the title and reasons for the research, its purpose, aims, the approach to the unstructured interview and its length. Also, that the research and the findings are anonymous with no identifiable reference to the interviewee or client. It was confirmed the use and storage of the recordings and transcriptions will be anonymous, safely secured, not used for any other purpose, and scheduled for deletion on completion of the research, unless further permission is gained to use the data for future research.

A critical element of the briefing was to acknowledge the potential conflict of interest which needed careful management from an ethical research perspective. The researcher, also the interviewer, had previously been a peer consultant on the ITD&DT programme and worked with each interviewee for several years. To avoid influence and bias, this was fully considered when designing the research method and plan for how the research and data analysis would be undertaken, for example, allowing participants to control the flow of the discussion to reduce the interviewer's influence (Kvale & Brinkmann, 2009).

For the research design, and when undertaking actual interviews, the researcher adopted what Roulston (2010) cited in Brinkmann (2020 p.431) as a Neopositivist approach by taking a "non-interfering" or "non-directive" role allowing the interviewee to reveal the "essence of his or her experiences" and lessons gained. This ensured the data collected was robust and trustworthy, that any conflict of interest the interviewer may have, as well as any bias or influence, was avoided or minimised. The aim was to provide each interviewee with the opportunity to freely think and speak about the lessons and experiences they felt were most significant. It was therefore emphasised that the scope was broad and could include lessons and experiences which drew on any relevant aspect of the programme, providing freedom for interviewees to share.

The aim of the up-front verbal and email briefs was to set the scene and minimise the interviewer's intervention in the unstructured interview, to avoid interviewer bias and influence. The researcher believed the quality of the up-front briefs and conversations were critical.

During interviews, the researcher employed active listening enabling the researcher to fully concentrate on what was being said, also helping the participants to think and speak freely, feel respected, expert, comfortable and heard (Brinkmann, 2020, p.434). The researcher's input was kept to a minimum ensuring the strategies outlined by Patton (2015), including maintaining a neutral tone, avoiding leading questions, and allowing participants to shape the conversation, ensured the data reflected their authentic experiences.

At the end of the interview, all interviewees independently commented that they found the interview to be cathartic and provided a useful opportunity for personal reflection.

Data Analysis and Write Up

Initially, transcripts were cleaned and anonymised, and a code known only to the researcher was used to differentiate between them. Each transcript was analysed using the six-phase approach to Thematic Analysis proposed by Braun and Clarke (2006, p.87), and detailed reference was made to their 15-point checklist for good thematic analysis Braun and Clarke (2006, p.96). Nowell et al. (2017 p.2) described Thematic Analysis as a method for "identifying, analysing, organising, describing, and reporting themes found within a data set", referring to its ability to produce trustworthy, insightful findings. Braun and Clarke (2006, p.7) suggest that "a theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set." Themes were identified based on this guidance. During the analysis, the researcher maintained an inductive approach, as suggested by Frith and Gleeson, (2004, p.42). This process was as follows: transcripts were thoroughly read and text considered to be relevant identified and coded. Following this, sections of the text which dealt with the same or similar meanings, were grouped together to construct Themes and Lessons and data was reviewed to validate its categorisation within a Lesson, and cluster each Lesson under one of 7 broad Themes (Frith and Gleeson, 2004, p.42). A hermeneutic approach was applied to iteratively interpret the data by moving between its individual parts and to uncover deeper lessons and themes (Gadamer, 1989).

Reflexivity was central to data analysis, with the researcher aiming to follow the principle of "explicit self-aware meta-analysis" by maintaining awareness of his prior involvement and its potential impact on his interpretation of the data (Finlay, 2002, p.1). Gilgun (2020,

p.17) suggests that “trustworthiness and authenticity arise from immersion, seeking to understand the perspectives of others in context, reflexivity, and seeking multiple points of view” and that “Researchers who have applied these principles will produce reports that are trustworthy and authentic.” In undertaking the data analysis, the researcher applied these principles aiming to achieve authenticity and trustworthiness in the findings.

The researcher’s aim in writing up the findings, was to do this in a memorable and interesting way, using the principles of Grab to directly quote and convey the lived lessons and experiences of the consultants (Gilgun, 2020, p.1007).

Research Findings

Emerging Themes

When analysing the data, the researcher found a high-level of agreement in the view of the consultants, resulting in several broad themes emerging, under which the lessons naturally fell. The Themes are; Strategic Direction, Planning and Governance; Leadership and Sponsorship; Organisational Culture and Competency; Procurement and Commercial; Data Integration and Technology; Project Management and Delivery; and Continuous Improvement.

Each Theme and associated Lessons are explored below, with an interpretation of the Observed Context the interviewee is referring to, together with a direct or abridged supporting quote from transcripts, where appropriate. The different interviewees’ contributions are indicated by P1, P2 and P3.

Theme 1: Strategic Direction, Planning and Governance

Lesson: There is a high probability that at inception, an infrastructure mega-project JV will have little or no vision or strategy for ITD&DT.

Observed Context:

Interviewees explained that following the formation of the JV, the mega-project began in a greenfield state, initially resulting in gaps in strategic direction, planning, project frameworks and governance, and this led to confusion and inefficiencies across the programme. From the ITD&DT perspective, there was no vision, form of brief, or plan.

“What became clear, was that there wasn’t really a clear strategic intent.....no strategic vision or targets.” (P1)

“...there wasn’t any sense of objectives, strategic or tactical.....We had to develop that from scratch...” (P3)

“We started with no existing frameworks for IT, data and applications.” (P2)

Lesson: That inadequate ITD&DT related planning and cost estimating models lead to budget escalations.

Observed Context: As the project progressed, the consultants faced the challenge that budgets allocated by the client for IT were inadequate for the task in hand and further applications for budget were needed to cover short-falls or where no adequate budget had been allocated in the JV’s estimating and tendering phase.

“I guess my first lesson learned in major civil engineering mega-project delivery is their estimating models are flawed and broken, which means it’s one of the drivers around why cost escalates so quickly.” (P1)

“What became evident...was the model that they’d applied for funding was actually no different to the model that every major civil engineering company applies when they bid for a JV mega-project...which is really flawed and skewed”...“that model is based off how they budget for people working internally within a job, not for how they budget for a JV that’s almost like setting up a business from scratch. So, it’s a really immature model.” (P1)

“Every stage of this started to feel really difficult...largely because technology wasn’t really fully woven into the...(client’s) tender and the cost submission.” (P2)

“...it highlights the need to use proven methods that are robust.” (P3)

Theme 2: Leadership and Sponsorship

Lesson: The critical need to continually manage various stakeholders, leadership styles, differing agendas and experiences, to obtain the necessary senior leadership team sponsorship, guidance, and support for all initiatives.

Observed Context: Interviewees valued the fact that key leaders with the necessary decision-making authority enabled innovative approaches and solutions to be explored, highlighting the essential nature of leadership and sponsorship from those with key roles in the client’s organisation.

“The success of our delivery...was always driven by them (MD, Commercial Director, End Client Director) just because they gave us the freedom to explore different ways of tackling traditional problems....”Unless it was strategically agreed and sponsored through the chain, it didn’t matter what that individual did. You (me, he or she) were never going to deliver.” (P1)

Interviewees also described the impact caused by frequent changes to senior and key leadership roles, including instability and inconsistencies in direction which constantly needed addressing, as it impacted ITD&DT. Most leaders lacked experience with large-scale ITD&DT which limited their ability to provide effective guidance. Interviewees needed to sufficiently educate and build the necessary relationship before fully productive work could be done and support gained.

“There was no stable leadership team – five CEOs in four years disrupted continuity.” (P3)

“The client’s leadership team wasn’t experienced with large IT system.” (P2)

Lesson: Careful management and influencing of senior stakeholders is necessary, so they understand, sell and support a vision as their own.

Observed Context: Interviewees explained, it was frequently necessary for them to put aside their emotional attachment to a vision, strategy, idea or innovation but to let go, re-position and sell it until the senior leadership understood it, the benefits, return on investment, and were prepared, and able to own it.

“It required us to put our egos aside for one second and sit in the room to rephrase our vision so that they really believed it was theirs, and so that they took the credit for it. And then once they took the credit for the vision, it became easy to set the strategic targets...but of course, that was our vision that we sold to them.” (P1)

Theme 3: Organisational Culture and Competency

Lesson: Delivering the ITD&DT programme within an infrastructure mega-project and JV, where there are gaps in the necessary experience and competence, leads to missed opportunities and costly delays.

Observed Context: Interviewees cited a lack of experience, competence, and high turnover within the mega-project, as the root cause of missed opportunities and costly operational delays. Many senior leaders and heads of function had not worked in a mega-project that embraced a cloud first, best-of-breed strategy and did not always appreciate its benefits and opportunities. Also, business leads, and their teams, found difficulty articulating their requirements for applications, as they were unclear about policy and business processes and what worked at scale. Their preference was to stick with what they knew rather than explore cloud alternatives which aligned with the ITD&DT strategy.

“Just because it’s a mega-project does not mean that the JV partners have a legacy of leading and running technology projects with increased use of data and applications and many challenges arise as a result.” (P1)

“....the client’s leadership was not experienced with large IT systems...” (P2)

“...when you sat down to try and put pens or paper around what their requirements were....many of these people have never delivered something from this stage in a journey.” (P1)

Lesson: The importance of building trust where a siloed work culture, entrenched mind-sets and ways of working result in resistance to change.

Observed Context: Interviewees highlighted the need to proactively build trust, as members of the client’s team, who lacked experience outside of their own company and specialist function, on occasions saw the external IT consultant’s expertise in business and IT as a threat.

“...their only experience is delivering within that parent company and that function....they’re more suspect of external consulting guidance coming in.” (P1)

This contrasted with the trust the senior leadership team had in the consultants:

“The level of trust was there...that we were doing the best thing possible for the organisation and that I think really helped in pushing a lot of these initiatives forward.” (P3)

Lesson: The importance of knowledge transfer and avoiding the loss of context within an infrastructure JV.

Observed Context: One of the interviewees commented on the high employee turnover within the JV emphasising the impact on the delivery of the ITD&DT programme, as vision, knowledge and context was frequently lost. This resulted in delay and re-work for the IT team, and less well-developed systems supporting operations.

“A lot of maybe context was lost as those people moved on or went elsewhere...Maybe some of the original vision was lost in translation.” (P3)

Theme 4: Procurement and Commercial

Lesson: The importance of aligning procurement processes with overall strategy and desired outcomes.

Observed Context: Interviewees recognised the importance of procurement processes to the achievement of the cloud first, best-of-breed strategy and business outcomes. Interviewees expressed frustration, as consultants had insufficient trust in the JV to appropriately deliver the task, as the JV’s resources lacked the necessary competencies and expertise to successfully procure. Consultants therefore considered it to be essential for them to oversee and manage procurement processes end-to-end.

Interviewees also described how external end-client influence and political JV decision making have overridden robust requirements, technology and commercial procurement processes. This was not always in the best interests of total cost-of-ownership and value delivery, leading to issues, risks and inefficiencies.

“We found ourselves having to take more accountability perhaps than we wanted to in running those processes, you know, so procurement should run procurement processes....but found we had to project manage it from start to finish to achieve the outcomes.” (P1)

“The X project....was kind of enforced upon us....It was too big. It was too expensive, and it required a multitude of people to work through....We could have done the same things...a lot cheaper.” (P2)

“There’s a lot of debate....which parent company is going to provide the software licensing...you (JV) didn’t think about the success of delivering. You (JV) never thought about the end journey from start to finish.” (P2)

“We defined elements of the balance scorecard to ensure that, you know, enablers of the overall vision and strategy were woven into that to ensure that even if people lost faith or didn’t believe in the strategy that they were driven through a set of processes that forced them back to thinking about the strategy.” (P1)

Lesson: When working in the construction sector under the New Engineering Contract, prepare for significant challenges and disputes, but operate co-operatively, effectively communicate, maintain good quality records and plans and address risks and changes promptly.

Observed Context: One interviewee explained his deep disappointment that after years of a good working relationship, the client’s commercial team did not act with integrity on commercial matters prior to the end of the engagement, as the JV failed to maintain full and accurate records. This resulting disingenuous behaviour impacted trust and co-operation and resulted in an adversarial relationship and potential litigation.

“The commercial teams adopted disingenuous behaviour, you know...weren’t operating with the integrity we expected and that left a very bitter taste in our mouth.” (P1)

Theme 5: Data Integration and Technology

Lesson: The critical importance of mapping data flows and system interactions.

Observed Context: Interviewees highlighted the need, at the very start of the project, to understand the landscape, especially the main complex data flows within the JV and

between subcontractors, end-client, parent organisations and publics. This provided inputs and a baseline for the design of the ITD&DT, its delivery architecture and processes. this 'whole picture' view had value for the consultants, but also for senior leadership, functional and technical leads, as it enabled improved understanding of how the JVs operations worked as well as being a catalyst for more systemic thinking. It enabled consultants to talk with authority about ITD&DT but also about the business itself, enabling them to add considerable value.

"Drawing out a map of a civil engineering mega-project was, I think the most important and the most enjoyable thing for me to understand how the different functions fitted in and how the data flowed – all the different applications interacted with each other." (P2)

Lesson: Data integration and interoperability within an infrastructure mega-project JV has the potential to improve insight, problem solving, decision making, processes, operations and efficiency.

Observed Context: Interviewees referred to the introduction of a middleware layer which enabled integration and seamless data flow between different applications, so that no application sits in isolation, was an enabler of data integration which drives out costs and improved processes by using a digital twin, also enabling data analysis and new data-based insights.

"....the way civil engineering projects have been run in the past have been very small, self-contained, where data has been on people's laptops....this is huge and complex in comparison." (P2)

"We needed to approach how to develop the insights, how to develop the models for the future so (this and) future mega-projects could learn off this." (P2)

"One of the big things that we introduced into this mega-project....is to develop this thing called an integration or a middleware layer...It's like a membrane that surrounds applications, where they can feed data into it....So that's one of the fundamental building blocks that we put in place right from the start." (P2)

Lesson: External pressures to deliver short-term results is high and may undermine strategy and commitment for using shared data driven insights to drive continuous improvement and associated efficiencies.

Observed Context: P2 explained his frustration at the JV's senior leaders, who after giving support for several years, allowed political and commercial pressures to shift their priorities from continuous improvement to short-term construction delivery, and to compromise on efficiency improvement. The result was that commitment to data-driven

insights, continuous improvement and realising efficiencies over time waned, and the opportunity to understand the full benefits to the JV (and industry) of this approach, was missed.

“The inability to leverage actionable insights and data for actionable insights, was a major frustration, due to a lack of appreciation from senior management, whose focus shifted to the short-term of just getting things done.” (P2)

Theme 6: Project Management and Delivery

Lesson: The need for an appointed owner and accountability framework endorsed by all senior stakeholders, to ensure effective ITD&DT systems delivery.

Observed Context: Consultants experienced a lack of systems ownership from the business and needed to find resolution. In addition to robust plans and accountability frameworks, the role of Information Asset Owner was defined, and endorsed, creating full accountability for the integrity, success or failure of processes, platform, and data with all plans requiring approval by senior stakeholders.

“Governance frameworks and clear accountability was essential to leadership involvement and ownership of outcomes....we made senior leaders accountable as ‘Information Asset Owners’ for processes, platforms and data....governance enforced the strategy...processes like scorecards mandated alignment to cloud-first goals.” (P1)

Lesson: The need to challenge business owners to understand detailed functional and non-functional requirements before selecting a platform or application, to ensure this aligns with functional, business and technology strategy.

Observed Context: The interviewees found it challenging to get good quality requirements from stakeholders, highlighting the need to guide systemic thinking and produce the right kind of requirements. Consultants advocated for a function-first approach, prioritising business needs and the taking of a 360-degree end-to-end perspective before selecting platforms and applications based on functional and non-functional requirements. This was to avoid functional scope creep, ensure best-in-class, strategy compliant applications and services were selected, rather than the stakeholder’s familiar solutions, which may not deliver the necessary best-of-breed functionality.

“One of the big things I tried to do right at the start was not look at individual applications...I was trying to change the philosophy to look at functional areas and what the functional area needed to achieve, before going down to that level and understanding what the (actual) application is (should be).” (P2)

“We felt the requirements coming out of stakeholders weren’t really of great quality....people repeated things they had done before, not realising what they wanted to do in the future for projects of this size. So, we had to kind of garner and nurture many of those requirements.” (P1)

Theme 7: Continuous Improvement

Lesson: The need for repeatable ITD&DT best practice blueprints, plans and methodologies, as well as systemic, comprehensive Knowledge Management and sharing at JV set-up and throughout all subsequent phases of the mega-project.

Observed Context: Interviewees expressed their surprise that at no stage was there any best practice blueprint, frameworks, guidance, shared learning, and that policies from the JV parent companies and end-client were slow to materialise, and not always sufficiently comprehensive.

“My point is, it feels like there is no clear framework for what good looks like for them,....it’s why the current engagement feels so uncontrolled.....relying on experience, - now experience could be good or bad.” (P3)

“When we approached the parent companies to understand how they wanted us to handle just the data aspect...their stance was well, we don’t know, and we don’t have any methodology – we haven’t ever created one.” (P2)

One consultant described how he had developed a reusable architectural blueprint which would be extremely useful to future large civil engineering projects. The problem being there is no obvious learning, re-use and knowledge management mechanism to achieve this.

“I’m very confident that through this mega-project...I think what we’ve developed is a good architectural blueprint....to build it in a way which is almost kind of building blocks, so we can pick and choose whichever ones we want for any future mega-project.” (P2)

On the prospect of carrying out work in the next phase of the mega-project, one interviewee said:

“I’m engaged in conversations with the teams delivering the next phase and what it very much feels like is those teams are actively wanting to go back seven years. To start to do this from scratch and don’t understand the importance of learning....I’m done and it kind of fills you with a bit of dread, remorse, about this industry really.” (P1)

Discussion of Findings

The findings highlight significant challenges in delivering ITD&DT for infrastructure mega-project JVs.

Strategic Direction, Planning and Governance

The finding of a lack of clear vision and strategy at the outset is recognised by Abdullahi et al. (2023, P.2-3) who acknowledge that project inefficiency and complexity results from poor early-stage planning for IT and these strategies should be fully integrated into the mega-project JV's core tendering, budgeting and planning. Ward (2019, P.1993) recommends frameworks which incorporate stakeholder perspectives in initial planning, to avoid governance-related inefficiencies.

Leadership and Sponsorship

Ashkanani and Franzoi (2002, p.130) echo the research findings and recognise that successful mega-projects depend on effective cohesive leadership to align the competing priorities across diverse stakeholders. Fayaz et al. (2017, p.76) recognise the importance of senior leadership support prioritising and executing IT initiatives. The importance of leading beyond authority is recognised by Middleton (2007, p.4) which she describes as “earning legitimacy with ideas that resonate” and in the case of the interviewees, initiatives that a senior leader is prepared to own.

Organisational Culture and Competency

The findings recognised that critical barriers include culture, competency gaps, resistance to change and siloed thinking. Abdullahi et al. (2023, p.3) acknowledge that deep-seated organisational mindsets and associated behaviours, are significant hurdles to digital transformation and Koeleman et al (2019, p.4) propose that within JVs, the dismantling of silos and building of collaboration is crucial for digital transformation enablement.

Boamah (2022) recognises the importance of knowledge management for the improvement of project efficiency which supports practices such as effective managed handover, knowledge transfer and supporting documentation.

Procurement and Commercial

Creating strategic alignment with business strategy and objectives is generally considered essential for achieving good procurement performance (Plantinga et al. 2001).

Gould et al (2022, p.168), suggests that issues relating to construction projects can frequently arise, and that parties should quickly take proactive action with the aim of avoiding conflict, and where disputes arise, to ensure quick resolution as appropriate for the sums being disputed.

Data Integration and Technology

In line with the findings, Koeleman et al. (2019, p.5) acknowledge that within mega-projects, short-term operational goals frequently frustrate and hinder the longer-term benefits of data driven decision making. They support the findings that external pressures and short-termism can undermine the strategic use of data and digital integration. Abdullahi et al. (2023, p.4) recognise that robust data governance frameworks are essential to ensure data-driven insights are effectively utilised to support interoperability and continuous improvement. Iriarte and Bayona (2020, p.59-60) highlight the need for “conformance between specified functional and non-functional requirements and their actual realisation.”

Project Management and Delivery

In support of the findings relating to the importance of clear ownership, roles and accountability frameworks, and quality of end-user requirements, Ward et al. (2019, p.2003) propose context sensitive, dynamic planning, which responds to challenges that emerge during the programme’s execution. Fayaz et al (2017, p.74) highlight the value of high quality functional and non-functional requirements, which align with business objectives, before procuring and adopting technologies.

Continuous Improvement

Koeleman et al. (2019, p.5) lends support to the findings and proposes that standardising best practices and applying learning through experience, can significantly enable and enhance outcomes for ITD&DT. This includes the development of repeatable blueprints, plans, policies and methodologies, as they are essential to right first time and continuous improvement throughout the programme.

Comparison with Existing Literature

The findings highlight several gaps in the literature which require further research; however, it must be stressed that for the purposes of this study, only a limited literature review has been undertaken, therefore, further validity analysis will be necessary. These are: insufficient empirical research on adaptive governance in the context of ITD&DT in construction JVs; lack of structural frameworks to effectively manage the contextual quality of knowledge transfer in construction JVs; studies on how to adapt existing procurement mindsets and contractual frameworks, to better support ITD&DT in a construction JV; balancing the benefits of longer-term development of data driven improvement, with short-term operational pressures and research into how best practice

blueprints relating to ITD&DT can be captured and re-used by future phase or new construction mega-projects.

Limitations of the Study

The focus on lessons and experiences in a single infrastructure mega-project and the reliance on the interviewee's experiences and lessons introduces subjectivity and limits the generalisability of the findings. The sample size and length of interviews will have limited the immersion achieved (Gilgun, 202). It would be appropriate for future research to adopt a multi case study approach, so that comparative analyses across diverse construction mega-projects can be achieved.

Practical Implications

The research findings and areas for further research provide insights which may be of use to leaders and managers of infrastructure mega-projects JVs and to ITD&DT consultants or in-house staff. Recommendations for senior leaders are given below.

- 1) Embed ITD&DT blueprints and strategies into all phases of the mega-project, but critically, in the tender and estimating phases so visions, plans and budgets are realistic;
- 2) Establish a governance body and performance framework within the infrastructure JV to oversee ITD&DT integration throughout all phases of the mega-project;
- 3) Introduce education and change management programmes tailored to specific JV related challenges impacting ITD&DT strategy and implementation;
- 4) Appoint a Chief Data Office (CDO) to lead systems interoperability and data strategies;
- 5) Define functional and non-functional specifications at an early stage in the programme and ensure a tight link to strategy is maintained;
- 6) Establish Knowledge Management and ensure rigorous handover processes to ensure continuity, context and application of previous knowledge and learning.
- 7) Formally and regularly review ITD&DT strategies and plans to ensure tight alignment with mega-project objectives and take remedial action as appropriate.

Summary

This research explores the experiences and lessons of consultants delivering the ITD&DT programme within an infrastructure mega-project. Each Theme and Lesson provides focus on areas which present challenges that significantly influence the success of the ITD&DT initiatives in the dynamic and complex environment of infrastructure mega-project JVs. The findings are specific to this case study but are also likely to be relevant to other construction mega-project JVs.

The study's core contribution is the identification of interdependencies between strategy, governance, leadership, and data integration as critical enablers of ITD&DT. It also highlights the urgency for the construction sector to effectively adopt modern, integrated digital and data strategies which, when effectively planned and implemented, can drive continuous improvement, process and operational transformation, significant efficiencies, increased productivity and innovation.

This study raises the need for a change in thinking in infrastructure mega-projects and the JVs that are an intrinsic part of delivering them, in terms of their adoption and use of ITD&DT. As the construction industry moves to become more digitally based, it must embrace this technology in a strategic, holistic and integrated way, as it transformation as an industry has, as one of its dependencies, the strategic, effective and efficient adoption of ITD&DT. As JVs are a key part of mega-project delivery, they must become accountable and responsible for ITD&DT's cost of ownership, benefit realisation and return on investment.

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