sustainability

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Reimagining Infrastructure Megaproject Delivery: An Australia—New Zealand Perspective

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Abstract: Infrastructure megaprojects are increasing in size and number worldwide. Widespread shortcomings such as cost overruns, delays, litigious threats, and community opposition are now so pervasive there is a clear mandate to rethink the way we plan, deliver, and operate our infrastructure. In this context, we situate this research to understand how megaprojects can be set up for success. Data were collected from responses to a questionnaire survey, interviews, and case studies. The questionnaire was fielded by multiple agencies involved in infrastructure projects, such as engineers, construction organizations, and government delivery agencies. For qualitative insights, we conducted 30 interviews with participants from these agencies and studied cases that successfully implemented the themes identified. The results highlight the three themes with the highest impact in delivering projects successfully: (1) Improved integrated planning, business cases, and front-end engineering design; (2) efficient use of contracts; and (3) strengthening government and political engagement. This research contrasts the literature on megaproject success with data collected from questionnaires, case studies, and interviews. Collecting solutions that have solved issues effectively is an innovative aspect of our methodology, with these findings holding considerable value for ecosystem practitioners. Thus, we contribute by highlighting eight cost-effective, relevant, and efficient ways for reimagining infrastructure megaproject delivery.

Keywords: infrastructure; megaprojects; Australia-New Zealand; project success

Citation: Ninan, J.; Clegg, S.; Burdon, S.; Clay, J. Reimagining Infrastructure Megaproject Delivery: An Australia—New Zealand Perspective. *Sustainability* **2023**, *15*, 2971. https://doi.org/10.3390/su15042971

Academic Editors: Weiwei Lin and Jun He

Received: 28 December 2022
Revised: 30 January 2023
Accepted: 3 February 2023
Published: 7 February 2023

1. Introduction

Infrastructure is essential for the socioeconomic development of a country or region. These projects involve the construction of motorways, railways, airports, power plants, dams, oil and gas extraction plants, processing projects, and stadiums for major cultural events, such as the Olympic games, among others [1]. The peculiar characteristics of large investment, long duration, and technical, political, and social complexities [2] result in megaprojects causing long-lasting and multiple impact on the economy, environment, and society [3]. It is well documented that megaprojects that fail to come in on time, on budget, and on specification can be critical for the organizations delivering them as well as, on occasion, the governments that sponsor them, that sometimes lose office in negative public reactions to perceived failures [4]. Due to repeated high-profile failures of megaprojects, the public perceptions of these projects are increasingly negative [5]. Widespread shortcomings, such as cost overruns, delays, litigious threats, community opposition, and low success rates, are now so pervasive that there is a clear mandate to rethink how we plan, deliver, and operate our infrastructure.

Globally, the need for infrastructure investment is forecast to reach USD 94 trillion by 2040. A further USD 3.5 trillion will be required to meet the United Nations' Sustainable Development Goals for electricity and water [6]. A report by McKinsey [7] estimates that

for the world to keep up with expected GDP growth, there is a need to spend about USD 57 trillion on infrastructure by 2030. In Australia, the value of megaprojects has increased from AUD 50 million in 1990 to AUD 500 million in 2000 and to AUD 8 billion in 2015 [8]. Overall, 9.8% of the Australian GDP is accounted for by the infrastructure sector [9]. The increase in the size and complexity of these construction projects has led to these projects being increasingly exposed to risk [10].

The nature of infrastructure projects, regarding their relative success and failure, varies depending on the context, and risks vary depending on the institutional context of a specific state [11]. In their study of 28 completed projects in Australia, Ryan & Duffield [8] note that financial outcomes ranged from a 1% profit to a 43% loss. The need for research has been stressed by numerous industry reports within the Australian context, calling for new approaches to replace old models for achieving success in the new world of megaprojects [12].

In this context, we situate our research designed to address how megaprojects can be best positioned for success in the Australian and New Zealand context. We followed several discrete steps in the research process. First, we undertook a detailed literature review of risk management approaches in infrastructure megaprojects. Then, we considered a mixed method, with quantitative and qualitative data, to study the main themes contributing to project success. A questionnaire instrument was fielded to 180 senior professionals in the infrastructure industry in Australia and New Zealand. From the qualitative data from 30 semi-structured interviews, we highlight the main themes in project success and analyze the support they engendered as propositions amongst these infrastructure professionals. The results highlight the three themes for reimagining infrastructure megaprojects delivery: (1) Improved integrated planning, business cases, and front-end engineering design; (2) efficient use of contracts; and (3) strengthening government and political engagement. We contribute by highlighting eight cost-effective, relevant, and efficient ways for reimagining infrastructure megaproject delivery. We then conclude with the limitations and scope for future study.

2. Literature Review

The first step was to thoroughly investigate the available literature on the state of current knowledge related to setting up infrastructure projects for success. We reviewed papers regarding challenges, risks, and success criteria in different contexts through a snowballing approach to arrive at a list of focus areas for infrastructure megaprojects delivery. Having done this, we synthesized the literature on infrastructure risks and corresponding risk management and allocation strategies in infrastructure projects. The themes that emerged from this systematic review of factors instrumental for setting up megaprojects for success are explained below.

Theme 1—Government and political engagement: The Grattan Institute Report, 'Road to Riches: better transport investment' [13], argues that Australian governments have spent large sums of money on misaligned projects influenced more by a political agenda than community need. Projects are prioritized for their electoral, constituency, or publicity potential rather than on a cost-benefit basis. Infrastructure projects are often hastily promoted as governments take advantage of the window of political opportunity [14]. In the process, projects can be awarded without a proper analysis by cloning inadequate models from other countries or awarding projects to less-than-optimal consortia. As projects become more complex, greater information sharing across state and federal infrastructure agencies becomes necessary. In part, these needs are met by multiple government agencies, such as Infrastructure Australia for New South Wales (NSW), the Office of Projects Victoria (OPV) for Victoria, and the NZ Infrastructure Commission (NZIC) for New Zealand. The dedicated governmental agencies that support the delivery of infrastructure projects have seen positive results in terms of greater collaboration across project proponents. Project maturity has resulted in improved contracts, delivery of projects, general project education, and a positive shift in workplace culture, along with greater support for private consortia.

Theme 2—Integrated planning, robust business cases, and front-end engineering: In an integrated planning approach, the infrastructure asset is viewed in relation to land use and environmental systems, considering both direct effects, indirect effects, and the relations between them [15]. Infrastructure projects are viable only if a robust and long-term revenue stream throughout the concession period can be established [16]. Given the potential for community resistance to derail project schedules and threaten their legitimacy, early community engagement is significant. The significance of the legitimacy of proposed project benefit estimates is demonstrated by the latest figures from Infrastructure Australia [17]. These highlight that around AUD 20 billion worth of projects have been delayed, canceled, or mothballed due to community opposition over the past ten years. Investing in the legitimacy of infrastructure projects regarding community expectations saves time and money [18]. Early engagement workshops with contractors, consultants, and delivery agencies will enable many risks to be identified and assessed at an earlier stage of the project life cycle. Such workshops aim to create conditions for rich interaction, debate, understanding, and learning among project stakeholders [19].

Theme 3—Choice of contract: Standard contracts and standard tender documents can reduce transaction costs in the form of tendering and legal fees as well as reduce costs to the private sector in formulating bids and to the public sector in assessing them [20]. Such contracts have to be implemented consistently across infrastructure agencies by including risk- and benefit-sharing clauses to enable them to benchmark time, cost, safety, environment, and community relations [21]. To realize the best from these standard contracts, joint training is recommended for both commercial and legal staff in Government agencies and delivery partners in their consistent use. Alliance contracts, which involve highly collaborative project delivery that encourages the partners to exploit innovation opportunities, thus, promoting economic, environmental, and social sustainability, are recommended for major infrastructure projects likely to entail very high degrees of uncertainty [22]. Effective and fair allocation of risks on an agreed basis between parties can reduce dispute occurrence during the concession period [23]. The propensity of government agencies to add additional risk to the contract at the preferred bidder stage should be limited.

Theme 4—Increased confidence in project pipeline: Additional resources and time allocated to government infrastructure bodies can improve coordination in bringing megaprojects to market and thereby increase project success. All major infrastructure projects should be subject to review and endorsement prior to contract by relevant infrastructure agencies, with an audit done post-completion to validate whether the projected benefits transpired and at what costs. One of the key risks in an infrastructure megaproject is the risk of a change of government, where a newly elected government can cancel or modify the terms of an agreement signed by a previous government. In Australia, with the M4 project awarded by the NSW State Coalition government in 1989, the newly elected Labor party government canceled the tolling on the highway [24]. In the case of Melbourne's East-West link road, which had a planned cost of AUD 22.8 billion, a change in government, coupled with advice from government officials, led to the project being canceled at the expense of AUD 1.1 billion [25,26]. Political risks, such as change of government, because of the federal structure of the constitution, are enhanced in Australia. Frequent state and federal elections may also affect commitments to infrastructure megaprojects. Federally, the three-year term of government is internationally a comparatively short period.

Theme 5—Increase emphasis on project assets' lifetime costs: Levitt & Eriksson [27] highlight that maintenance of infrastructure assets tends not to be provided to the standards specified in contractual agreements by private players. The reason for this is that operation and maintenance of an infrastructure asset only come into play a long time after any agreements are signed. By this time, the assignment of costs may be more contested. A Design-Build Finance Operate Transfer (DBFOT) contract stipulates a set period of operation to enable the private sector to design for the maintenance and operation phases of the asset. Demand risks are sometimes absorbed by the government; for instance, in the WestConnex project in New South Wales, the government shared the demand risks [28].

Likewise, in the Sydney Harbour Tunnel [29], the government shared the demand risk, which affected the project's performance. The operation and maintenance of an asset will be managed more effectively if demand risks are borne by the private sector. The increased use of DBFOT contracts has been seen as ensuring that the private sector will design for the maintenance and operation phases of the asset that, after operation for a stipulated time, they will transfer to the government. In addition, government accountability and visibility of the capital tied up in the operations of existing assets can improve management and performance [30]. On an annual basis, governments should produce a lifecycle cost report, including capital versus operations data for each of their major assets.

Theme 6—Reduced unknown contaminants and utility risk: Many projects face unknown risks in the form of contaminant risks or underground utilities which could not have been planned for earlier. Construction projects have risks that are 'known,' 'known-unknown,' and 'unknown-unknown' [31]. Unknown environmental conditions and utilities are the greatest threat to project success. Attempts to consider all risks, including unknown unknowns, would lead to more time being taken at the planning stage, risking an over-extensive allocation of resources [32]. Nonetheless, the risks can be moderated. To identify latent conditions and utilities, early work on complex brownfield sites should provide relevant information to all bidding parties pre-contract. The government should warrant the factual accuracy of data on ground conditions and utilities. There should also be proper flexibility in the contract to allocate these risks on a case-by-case basis [33]. The risk premiums for unknown risks will be high, and the bidding entity may heavily price these kinds of risks if there is no provision for flexibility in the contract, a situation that can result in poor value for money from the project. An agreed approach for addressing non-contestable utility works should be implemented across agencies and contractors. Project disputes can be reduced through negotiations and the development of an agreed claims process to manage variations resulting from unknown environmental risks [34].

Theme 7—Collaborative industry ecosystem: Significant value can be attained by designing a collaborative culture between clients (state agencies) and delivery partners (construction firms and service delivery). A no-blame culture can promote collaboration and innovative thinking in infrastructure projects [35]. Collaborative culture competencies can be developed [36]. Inception workshops to establish strong alignment between parties to deliver successful project outcomes can be staged [19] to help develop such a culture. An integrated claim management system can simplify the claim process and implement a standard approach to dispute avoidance, variations, and claims resolution [37]. Advantageously, all major projects contain a senior-level dispute avoidance forum to identify potential areas of dispute before they arise. Although alliance contracting, Early Contractor Involvement (ECI) Contracts, etc., have been cited as two delivery options, benefits may result from other organizational strategies, for example, encouraging increased movement of staff between private and government sectors through using secondments and placements to encourage increased awareness of the challenges faced by each party.

Theme 8—Using technology and data more effectively: Improved use of integrated technology across all infrastructure delivery partners using common software and standards will potentially improve the likelihood of a successful project [38]. The use of Information Communication Technologies (ICT), such as Building Information Modeling (BIM), Geographic Information System (GIS), etc., by all parties undertaking the infrastructure delivery, can improve coordination and project performance [39]. Capturing and sharing lessons learned and communicating best practices across the sectors have improved overall industry performance [40].

3. Research Method

A comprehensive list of elements that can position infrastructure projects for success was compiled through the literature review. The literature review served as preparation for designing a survey instrument that could pick up variance concerning the eight themes that emerged. To understand how infrastructure megaprojects can be set up for success, mixed

method research was carried out, combining quantitative questionnaires and qualitative semi-structured interview data.

As the aim of the research was to understand how infrastructure megaprojects can be established on premises likely to lead to success in the Australian and New Zealand context, we collected data from experienced practitioners predominantly located in NSW, Victoria, Queensland, and NZ (Figure 1). Respondents from different areas increase confidence and reliability of the data [41]. Following the suggestion of Klein & Muller [42], we sought responses from the most qualified sources; hence, most of the respondents had more than twenty years experience working in infrastructure megaprojects (Figure 2). Ninety percent of the respondents had more than ten years experience and held senior positions in their organizations, such as director, general manager, or project manager. The respondents belonged to different sectors involved in infrastructure megaproject delivery, such as business advice, government, consulting, construction, and industry associations. Thus, we collected data from people able to contribute knowledgeably to our research agenda given their experience, place of experience, and sector, as per the recommendations of Bono & McNamara [43].

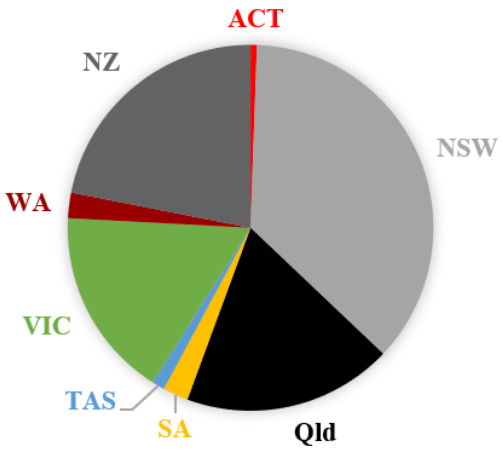

Figure 1. Location of respondents.

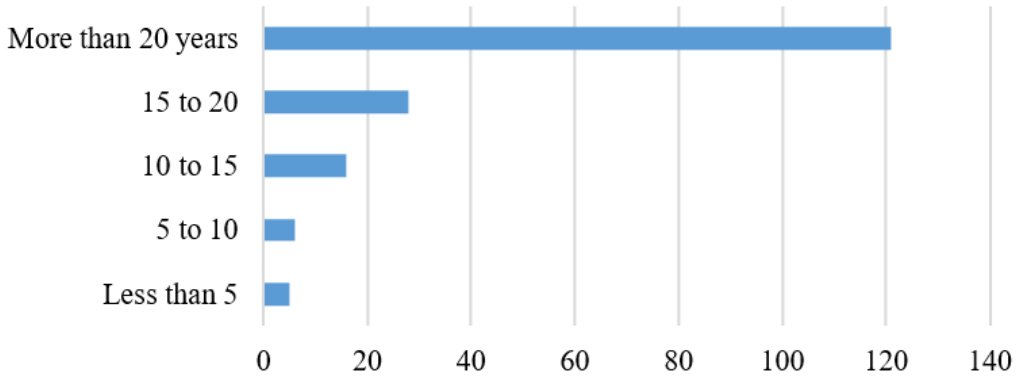

Figure 2. Experience of respondents.

The questionnaire instrument, consisting of two sections, was explicitly designed for use in interviews with a sample of experts in infrastructure projects. While Section 1 sought demographic information on the respondents, Section 2 contained questions related to the themes and sub-themes identified from the literature review. The importance of each theme and sub-theme, expressed as propositions, was ranked by respondents using the following response categories: (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree, and (5) strongly agree. Each proposition was assessed against the mean score and net support, i.e., the number of respondents who agreed or strongly agreed as a percentage of total respondents. The research survey was undertaken over five months, from 1 May

to 30 September 2019, with contributions from 180 respondents engaged in all aspects of major infrastructure delivery. Of the overall responses, 140 were obtained from the online survey, and 40 were collected in person. A sample size of over 100 is generally considered robust for questionnaire-based research [44].

In addition to the questionnaires, we conducted 30 semi-structured interviews to analyze the support for the themes. We identified five categories of ecosystem participants categorized as delivery agencies, consultants, construction companies, business advisory organizations, and industry associations. For each interview, the following protocols were undertaken. First, the interviewees were asked to sign a standard research confidentiality agreement acknowledging that responses would be used for research purposes only and would be treated confidentially and that all responses would be 'anonymized'. Second, a series of exploratory open-ended questions were used, such as (a) What examples can you think of where major infrastructure projects do not get delivered effectively? (b) Thinking of these projects, what risks materialized to deliver the poor outcome? (c) How could these risks have been allocated differently to avoid or reduce the impact or likelihood of the poor outcome? Follow-up questions investigated the phenomenon stated to a greater depth. Finally, the interviews were transcribed, and a thematic analysis was undertaken [45]. Conducting interviews and exploring specific case instances enabled us to use a triangulated approach to validate the survey data. Love et al. [46] highlight that a triangulation approach is likely to gain a more complete understanding of a given phenomenon as it employs both qualitative and quantitative data. As the data was triangulated, we shared insights from the research instruments with key stakeholders and industry forums in focus groups to obtain case examples that supported the rankings the respondents had provided. Case examples were intended to provide an in-depth understanding based on live examples of projects positioned for success. These cases were compiled from sources, including leads mentioned during interviews and through document readings. The survey results, interviews, and case studies are discussed in the following section.

4. Findings and Discussion

Respondents were asked to list the importance of themes and sub-themes identified from the literature. The findings from the qualitative interview and case study data are also discussed to enable in-depth understanding. The responses by the 180 respondents to each theme are shown in Figure 3.

The highest theme, 'improve integrated planning', and lowest theme, 'improved industry ecosystem', were similarly ranked in the Australian and New Zealand responses. An ANOVA comparing the difference of means between Australia and New Zealand was conducted for each of the eight themes. The only theme significantly different was 'efficient choice of contracts', with an F Statistic of 25.46 > 6.806 F Critical (a = 0.01), which is significant at alpha < 0.01. The New Zealand mean is significantly less than the Australian mean for this theme. For all other themes, there is insufficient evidence to establish a difference in means between the two countries. There is a similar ranking between Australia and New Zealand of the potential impact of factors deemed significant for a project to be delivered successfully, except for attitudes to the 'efficient choice of contract'. The distinctiveness of this theme's different rating in terms of the reasons for the significant difference between the two countries requires further investigation.

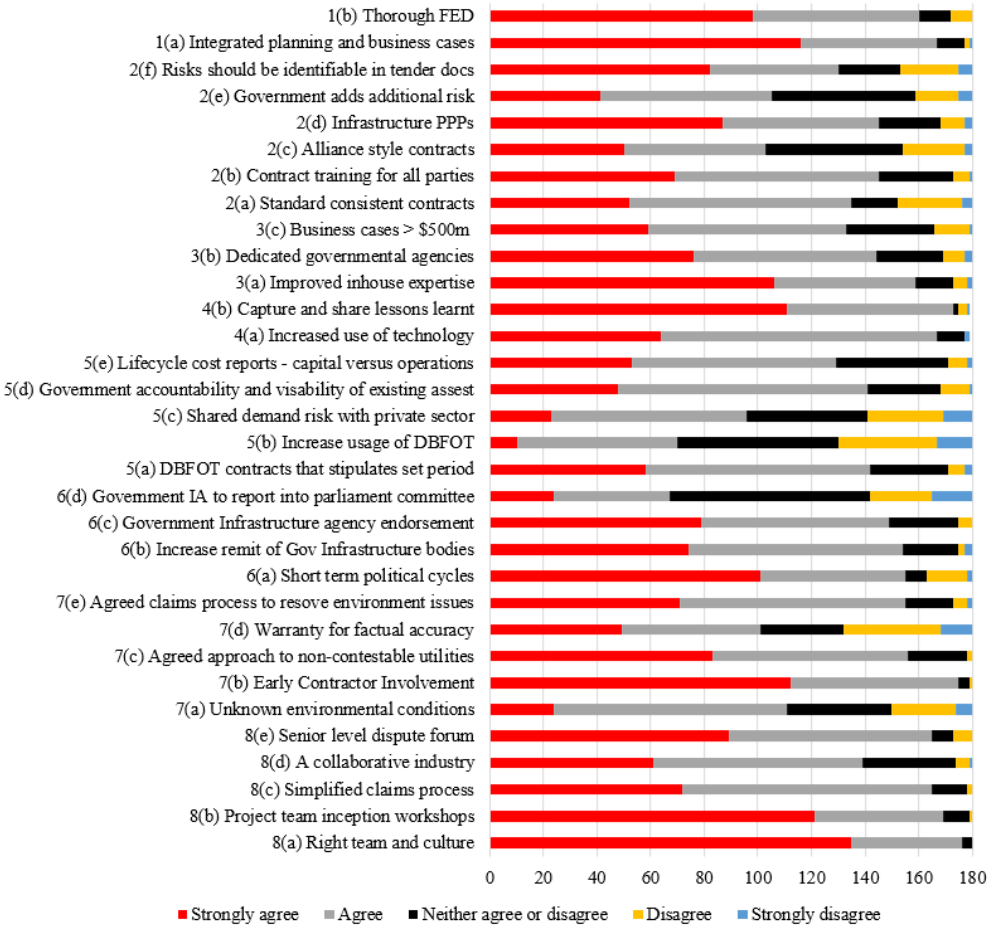

Figure 3. Response to themes and sub-themes.

4.1. Integrated Planning, Robust Business Case, and Front-End Engineering

As highlighted earlier, the respondents ranked this theme as the most important for megaproject success. Within this theme, a majority of respondents agreed with the proposition that early project inception workshops dictate how projects pan out in the future. A relevant case example of early project inception workshops is the 'Special Activation Precincts' [47], established as part of the 20-year economic vision of New South Wales (NSW), Australia. These precincts attract and grow businesses, stimulate the local economy, and provide more local employment opportunities. The precincts come with government backing and include faster and easier planning processes. In some locations, they feature government-led development, coordinated land use, and infrastructure planning, as well as business concierge services to help businesses start up in these Special Activation Precinct areas. Grants and interest-free loans are available for eligible businesses under the Regional Investment Attraction Package. The importance of such integrated planning and business cases across all types of infrastructure projects was agreed to by most of the respondents to the survey. This was supported by the comment of one of the respondents, as recorded below:

> *"We need to publish long term plans and strategies that are agreed on. Governments then broadly need to stick to them".*

Regarding the integration process, the respondents claimed that the business case approval process should be separate from political announcements:

> *"Mandate a public project business case approvals process that separates political announcements from a government decision".*

Thorough Front-end Engineering Design (FED) was also highlighted by respondents as important for project success. Infrastructure megaprojects, it was agreed, require a more integrated planning and robust business case process combined with thorough front-end engineering design. Even though this may mean fewer projects are awarded, these projects, it was suggested, will have better chances of successful delivery due to increased scrutiny and investments in the front-end. As Oh et al. [48] note, inadequate input at the front end of projects results in the fragility of plans in terms of constructability and return on investments.

4.2. Choice of Contract

90% of respondents agreed that having the right contract that is consistently used across both delivery agencies and construction firms impacts project delivery. The respondents agreed that PPP projects are most effective when risks can be appropriately allocated between parties. A respondent commented:

> *"Choose the right contract, allocate risk to the best party and recognize the value of alliances beyond the dollars".*

The respondents also agreed that contract training for all parties is required and contracts should be standardized as much as possible. A respondent criticized the use of bespoke authoring of contracts as below:

> *"Contracts should be standardized as much as possible, no bespoke authoring/negotiation/disputing; clear accountability between parties is critical".*

Standardized contracts such as the New Engineering Contracts (NEC) have been consistently used worldwide [49]. The NEC3 contract was credited as 'the unsung hero of the Olympic games' in London in 2012. The NEC4 suite of contracts is planned to be used at Sydney Water [50], with benefits claimed for Sydney Water, its partners, and ultimately customers as incentivizing high performance and increasing productivity.

The research highlights that standard contracts can be effective for a large number of projects when used consistently and with joint training for all stakeholders. Partnerships achieve higher levels of collaboration through a fundamental reallocation of risk amongst multiple parties with a level of joint liability and shared gain ensuing from collaboration.

4.3. Strengthen Government and Political Engagement

The impact of this theme is on the institutional environment surrounding the project rather than on the project directly, as in the other themes. The majority of respondents strongly agreed that strengthening the government by improving its in-house expertise can improve the delivery of infrastructure projects. Government in-house expertise, it was proposed, could be improved through additional resourcing, training, and adequate remuneration to attract talent. Supporting this, one of the respondents claimed:

> *"State entities need to have the expertise to quickly and appropriately assess in order to maintain delivery programs".*

The findings from this study are similar to the findings in the report on 'Government as an Informed Buyer' by Engineers Australia [51]. The report noted that as government agencies lose their engineering expert workforce through downsizing and outsourcing, they lose the ability to be a well-informed purchaser, thereby affecting the successful delivery of infrastructure projects. In delivering successful urban infrastructure, Koppenjan & Enserink [52] note that governments should build regulatory capacity by getting the right mix of expertise.

There was high overall agreement accepting the importance of dedicated government agencies to handle infrastructure projects, as observed through the combination of 'strongly agree' and 'agree'. The respondents highlighted that these dedicated agencies should not micromanage the contractor but rather only manage contracts, as highlighted below:

> *"We need skilled government staff who manage contracts, not skilled government staff that micromanage contractors".*

Multiple infrastructure projects worldwide suffer due to strategic misrepresentation from governmental agencies as they overestimate the benefits of the project and underestimate the costs of the projects in an attempt to get the project awarded, according to Flyvbjerg [53]. To avoid this, respondents claimed that government agencies should be transparent with contractors and reveal true forecasts for these projects, as quoted below:

> *"More openness at the Ministerial level to forecast cost and time to completion, with more willingness by senior executives within government agencies to reveal true forecasts is required".*

Thus, we highlight that tenure, experience, and a strong central infrastructure coordination agency are required for reimaginging infrastructure megaproject delivery.

4.4. Using Technology and Data More Effectively

The respondents agreed that capturing and sharing the lessons learned in infrastructure megaprojects would help set up better projects in the future. Participants felt that significant improvements could be made by learning from the past rather than repeating the same mistakes on future projects. One of the respondents claimed that success could be achieved by:

> *"Sharing of lessons learnt and best practice across the sector, improving monitoring of benefits being sought by projects, and improving monitoring of threats to project completion".*

The use of digital engineering can enable this capturing and sharing of lessons, especially in the initial phases of the project when all delivery partners are working across consistent digital platforms for ease of data transfer. The Darlington Upgrade Project in Adelaide's North-South Corridor was cited as a very good example of the use of digital engineering across all partners and its impact on delivering a complex project ahead of time on budget.

Sharing results more widely will enable lessons learned to be acted upon, with a decreased frequency of similar mistakes occurring in the future. Adding to this, the use of digital technology consistently by all parties affords an ability to identify and resolve issues early and provides a more integrated design for the project [54].

4.5. Increase Emphasis on Project Assets Lifetime Costs

The whole life cycle cost should be considered while selecting infrastructure projects. Projects should be selected based on the value provided rather than as an opportunity for a ribbon-cutting photo, as highlighted by one of the respondents:

> *"We do not do asset management very well. Instead, there is a tendency to look for a quick fix with new infrastructure that can be showcased and have a ribbon cutting photo event. Instead, we should look at the whole project life cycle use and when a project is being scoped out, we need to get the operators more involved".*

To provide more value, the respondents agreed on Design-Build Finance Operate Transfer (DBFOT) contracts, as they enable the private sector to design efficiently for the maintenance and operation phases of the project, thereby considering the entire lifetime costs. The respondents also suggested comparisons with alternatives before a project is awarded, as recorded below:

> *"Whole of environment and life cycle cost-benefit analysis and comparison with alternatives is required prior to a commitment to proceed".*

The stress on all stages of an investment life cycle is seen with projects in New Zealand as the government cabinet introduced circular objectives on its expectation for the management of investments as well as both physical and intangible assets.

4.6. Increased Confidence in Project Pipeline

The theme stressed that once a project has gone through the various planning and business case phases and engineering design, firms must be confident that the project will go ahead and not be canceled. Many stakeholders felt that too many projects had been rushed through based on the political cycle. The importance of a dedicated government agency to handle infrastructure projects was stressed, but respondents claimed there was a problem with these agencies when they were not independent. It was highlighted that short-term political cycles, leading to rushed project announcements, created a situation in which multiple megaprojects came to market simultaneously, thereby reducing the confidence of companies in the project pipeline. The respondents suggested that there is a need to spread the delivery of major projects in the long term instead of it being tied to government terms designed to maximize political advantage. To counter short-term political cycles, governments should develop long-term plans, as highlighted by one of the respondents:

> *"Develop a long-term plan and stick to it, avoid bleeding edge technology projects and adopt a strict delivery model based on a whole of systems thinking approach".*

In New Zealand, the NZ Infrastructure Commission publishes a pipeline of infrastructure projects [55] and therefore acts as a 'shop front' to display possible future projects. Such long-term plans can do much to counter short-term political cycles.

4.7. Reduce Unknown Contaminants and Utilities Risk

Reducing uncertainty around the unknown condition of ground contaminants, such as asbestos and other toxic elements, as well as the location of utilities, was seen to have a major impact on the success or failure of a project. The respondents agreed that early contractor involvement could help mitigate these uncertainties around environmental conditions. One of the respondents claimed:

> *"Better management of utilities and contamination risks via early works packages and Government should adopt a partnering solution-oriented approach".*

Other respondents have also called for more involvement and sharing of risks by the government as they are the ultimate owner of the asset, as highlighted below:

> *"Risk allocation has not materially changed over time; however, with the large increase in scale, value and complexity of the major projects, the consequences of the risks have grown exponentially. There needs to be some reconsideration of sharing critical risks with limited information and control (e.g., non-contestable utilities, contamination, latent conditions and ground conditions). An element of these risks should be shared by the government as the ultimate owner of the assets".*

It is also essential to share transparent data with the contractors during bid processes to enable the successful completion of the project. A Suitable claims process must be instituted to safeguard the contractor against unforeseen events.

To set up megaprojects for success, environmental impacts need to be reduced through early contractor investigations along with the transparent sharing of data with all parties.

4.8. Collaborative Industry Ecosystem

Megaprojects are delivered through teams, and having the right team culture was agreed by respondents as important for project success. In the Woolgoolga to Ballina highway project in New South Wales, Australia, the delivery partners undertook Early Contractor Involvement (ECI) initially to reduce the uncertainty and de-risk the project. They also implemented the whole materials procurement program with industry consultation to ensure all materials were available for the project with cost certainty. On the importance of partnerships in the delivery of projects, one respondent claimed:

> *"High-quality project management and professionals working for both the client and the contractor often focus on collaboration".*

In another case, the North Storage Tunnel construction of the Sydney Water was delivered through an alliance contract [56]. The management consultants to the project, who were experienced in large-scale construction projects, helped design a project culture that was explicitly crafted to encourage shared behaviors, decision-making, and values. A list of value statements was produced, the two core values of which were striving to produce solutions that were 'best for project' and having a 'no-blame' culture. Adding to this, increased movement of staff between the private and government sectors through secondments, placements, or deputation [57] can increase awareness of the challenges each party faces.

5. Conclusions

The research was conducted to understand how infrastructure megaprojects can be set up for success, i.e., be more cost-effective, relevant, and efficient. Learning from approaches to setting up projects for success in the Australian and New Zealand context can help infrastructure projects globally. From the eight themes identified from the literature review, the respondents highlighted: (1) integrated planning, business cases, and front-end engineering design; (2) efficient use of contracts; and (3) strengthening government and political engagement as the three main themes for success. The most supported sub-themes were (1) the early use of contractors to assess the environmental conditions, (2) constructing a highly competent project team imbued with a collaborative culture, and (3) implementing early inception reviews and sharing lessons learned. We have also highlighted some cases that were noted as having had success in implementing these themes.

We contribute to existing knowledge in multiple ways. First, there should be increased scrutiny and investments in the front-end of the project, even though this may mean fewer projects are awarded. Second, standardized contracts can improve transparency in projects and can also be used consistently in a number of infrastructure projects. Third, along with the themes that would most improve project performance, we also found less important issues. We found that even though the literature review recommends using design-build, finance, operate, and transfer contracts for success, these approaches did not apply in the Australian context. We used an innovative research design that combined a survey questionnaire with interviews and relevant cases, thereby employing both quantitative and qualitative research to gain a holistic understanding of how to establish infrastructure megaprojects for success. The examples where people dealt with an issue effectively came from several sources. These included cases from New Zealand, Victoria, NSW, and Queensland. Collecting solutions that have solved issues effectively is an innovative aspect of our methodology, with these findings holding considerable value for ecosystem practitioners.

The research has some limitations. There are different risks in the infrastructure sector, and the challenges due to the pandemic were relatively recent and unexpected. The implications of these are not considered in this paper since our data collection was conducted prior to the pandemic and Ukrainian crisis. The research was conducted only in the Australian and New Zealand context. However, while some of the above recommendations are specific to these contexts, given the similarities between their context and those of other parts of the world in similar OECD economies, some of the findings may also be tested and adapted in other regions. Since the Australian and New Zealand context are seen to be at the forefront of efficiency in handling infrastructure projects, these findings on setting up infrastructure megaprojects for success should be of value in other countries as well. Future studies can explore the key actions required from different agencies to deliver projects successfully.

Author Contributions: Conceptualization, S.C. and S.B.; methodology, S.B and J.C.; writing—original draft preparation, J.N.; writing—review and editing, J.N., S.C., S.B. and J.C; funding acquisition, S.B. and S.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by WSP, grant number 1032626 PRO18-5646-BURDON, for a research grant on "New Risk Mitigation Approaches for Infrastructure Projects".

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University of Technology Sydney (UTS HREC ETH18-2655N and 14-06-2018).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Restrictions apply to the availability of these data. Respondents have only consented to the use of data for this research project.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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