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Deploying the Hybrid Project Management Methodology Framework in Major Transportation Projects in the United Kingdom

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Abstract

This paper introduces a proposed Hybrid Project Management Methodology Framework, tailored for Project Managers engaged in overseeing large-scale road transport projects in the United Kingdom. Through a mixed-method approach comprising of a comprehensive literature review, a structured quantitative questionnaire administered to industry professionals, and a case study examining the application of Lean and Agile methodologies in a complex megaproject, this study identifies the prevailing project management methodologies in use within the UK Mega Transport Projects (MTP) domain. The surveyed professionals, primarily experienced project managers in construction, provided insights into the challenges encountered in MTP, helping to rank the most common methodologies and best practices. The findings underscore the prominence of hybrid methodologies, particularly Lean and Agile, in MTP delivery, alongside the importance of adopting additional methodologies tailored to project characteristics. Moreover, successful project outcomes hinge not only on methodology selection but also on the application of industry best practices, including collaborative partnerships, key performance indicators (KPIs), and others. This research contributes a focused examination of the impact of project management methodologies and best practices on MTP in the UK, offering insights into addressing associated challenges.

Keywords: Mega Transport Projects; Large Transport Projects; Project Management Methodologies; Construction Project Management Methodologies; LeAgile and PRINCE2 in Construction

Introduction

The complexities surrounding the construction of Mega Transport Projects (MTP), alternatively termed Large Transport Projects (LTP), have garnered growing attention in recent years. Transportation stands as a cornerstone of the global economy, facilitating the movement of both goods and individuals across an increasingly intricate multi-modal transport network. Various sources including Janelle and [1-6] underscore the significance of transportation services. Price Waterhouse Cooper forecasted a steady annual growth rate of 5% in worldwide Transport Infrastructure investment between 2014 and 2015. However, despite this promising outlook, MTPs are often mired in controversy and beset by numerous challenges. These challenges span diverse facets such as cost escalation, concerns regarding the value for money proposition, inherent uncertainties, risks, scheduling constraints, and shortages in labor and skills [7-9].

Presently, MTPs pose unique risks and challenges attributable to their sheer scale, which far surpasses that of smaller and medium-sized projects. Consequently, any alterations made during the construction phases of these projects can have profound implications for the organising entities. While a substantial body of literature exists on the challenges inherent in Transport Projects, the majority of proposed solutions tend to focus on systemic changes, process improvements, and technological advancements. Only a handful of studies delve into the application of specific project management methodologies (PMM) and their efficacy in infrastructure transport projects. The methodologies identified in existing literature encompass Lean, Agile, PMI, APM, PRINCE2, among others. Thus, this study aims to identify the most used project management methodologies applied in Mega Transport Projects in the UK based on a mixed study composed of a literature review analysis, a quantitative structured questionnaire and a case study on the application of Lean and Agile in a complex megaproject in the UK. Therefore, this study seeks to explore the implementation of hybrid methodologies alongside best practices to optimize project delivery in this domain. In doing so, it attempts to potential demonstrate the value of a Hybrid Project Management Methodology Framework for Project Managers in the delivery of mega road transport projects in the United Kingdom

Background and literature review

MTPs represent a distinct category within infrastructure project classification based on their scale. These projects are typically classified as mega or large owing to the involvement of numerous stakeholders, substantial budgets, and their profound impact on politics, economics, and the environment within the countries where they are executed. MTPs are inherently fraught with risks and uncertainties owing to their intricate nature. In the United Kingdom, megaprojects are generally categorised as those exceeding £1 billion in cost. According to [8], these projects constitute the largest proportion in the infrastructure sector in terms of both project count (302 out of 564) and expenditure (£127.44bn out of £410.96bn). The UK Government Pipeline Report

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of 2018 updated the pipeline of transport projects and programmes to encompass 256 initiatives with a total value of £122.9bn. Notably, there are 23 mega projects in the UK, with costs amounting to almost £150 billion. Prominent examples include rail projects such as Crossrail and HS2. However, MTPs span various sectors including roads, rail, airports, and seaports.

The literature underscores several common challenges encountered in MTPs. These include cost overruns [10], schedule overruns [11] often stemming from budgetary escalations [12], performance management, and stakeholder engagement aimed at achieving project objectives [13]. Additionally, the construction sector faces the challenge of low productivity, with global labour productivity growing at an average rate of only 1% compared to the manufacturing industry's 3.6% [14]. Notably, both [15] and a 2017 McKinsey report reveal that nine out of ten projects experience budget increases [14]. Moreover, [14] indicate that MTPs tend to encounter significant cost overruns, with budgets exceeding the original estimates by seventy percent and schedules surpassing the planned duration by sixty-one percent. In the context of the UK, the top five factors contributing to these challenges in MTPs include design alterations, risks and uncertainties, inaccurate project duration assessments, work complexity, and subcontractor non-performance [16].

The term "methodology" is defined by the organisation [17] as a structured system of procedures and techniques utilised in project management. Project Management Methodologies (PMM) is designed to ensure that project processes are conducted systematically, consistently, and effectively to achieve project objectives [18]. Project managers have the flexibility to choose either a single methodology or a combination of methodologies. Hybrid methodologies involve the integration of multiple methodologies. The effectiveness of a PMM is not solely assessed based on its application but also on its impact on organizational governance in project selection and evolution. For instance, research by [19] demonstrated that the application of PMM contributes to a 22.3% variance in project success. Moreover, organizations that comprehensively implement PMMs rather than using them as supplements tend to achieve higher levels of project success. Within the literature, "Project Management Body of Knowledge" categories such as PMBOK by PMI and APMBOK by APM serve as guidelines for various projects. PRINCE2 is also included in this category. Although some authors, like Chin and [20,21] do not classify these guidelines as methodologies, certain aspects, tools, or techniques from these guidelines can be applied based on the project requirements and complexity. The following are the most frequently mentioned methodologies in the construction-related literature:

Lean: The principles of this methodology have many benefits to the UK construction industry but are not being applied in general in this sector. Additionally, [22] observed that some structural and cultural barriers were affecting the development of this methodology, such as lack of lean understanding, lack of commitment from the top management and other stakeholders, and cultural and human issues. Lean principles help and promote sustainability in construction [23]. In addition, the implementation of Lean concepts seems to diminish the accidents on-site. According to Marzouk [24], the benefits of applying this methodology in the design improve the efficiency of a project. It helps to reduce the duration of the activities, improve the efficient utilisation of resources, improved productivity, safety, quality and customers satisfaction, reduced waste and cost, and others [25-27].

Agile: Based on the challenges of the UK's construction sector related to culture and the various stakeholders in large projects. It is common for large projects to have numerous sub-contractors and casual workers; this is a limitation to promote loyalty and trust in workers [28]. The methodology of Agile helps the design of a project, but in the phase of construction is complicated to apply due to the interrelated operations. The authors [28] highlighted that it could be very beneficial for the planning phase. However, the collaboration of stakeholders and a culture change in the construction sector is also necessary for the execution [29]. This methodology's main benefit is the flexibility that responds to change and fulfils the customers' [30].

Lean and agile: Other studies mix these two methodologies as a hybrid (Agile and Lean) or with other techniques such as agile combine with augmented reality [31]. For the case of the relation between Lean and Agile (LeAgile), the literature available in studies is highlighted by various authors such as [30,32-35]. LeAgile principles improve the efficiency in the activities of construction projects [35]. In construction [33], state that this combination helps with complexity and improves performance. As a combination is a solution to the challenges in construction projects, rather than using the lean approach alone in this sector [33]. Other benefits of Lean and Agile mentioned in the literature by are reducing waste and environmental footprint in the infrastructure construction. Also, this hybrid methodology is used with offsite construction [30].

PRINCE 2: The study of [36] found that PRINCE2 is difficult to apply in some areas in construction projects due to various facts like complexity in the terminology of the methodology, lack of clarity plan, it assumes every project needs a board, product-based process, iterative product delivery. However [36], highlight that their research is based on a review of documents and that there may be successful applications in the construction sectors of this methodology. Additionally, there was not found many studies about PRINCE2 in construction.

Scrum: There are some studies about scrum in construction in the literature. For example, one of [37] studies stated that scrum is beneficial to the design of construction projects. Moreover, the application of this methodology improved the interactions with stakeholders like the customers and the project team, the collaboration, individual responsibility and others [38]. Likewise, there is a framework applying this methodology in construction that optimises the time by enhancing the planning activities in construction projects [39].

Kanban: There are several studies about the use of Kanban, a lean approach to be applied in construction [40,41]. The key to improving production performance is to consider such factors as the size of an order, the standardization of the work breakdown structure to shape a construction environment with more uniform workflows and flexibility. The Kanban system is valuable for monitoring construction performance. However, for the Kanban system to operate effectively, it needs to be systematically approached before starting the make-ready process of scheduled tasks [42].

Scrumban: As a single methodology, Scrum helps the planning in construction; improve the team structures and communication to accomplish the activities efficiently. The mix of Scrum with Kanban can increase productivity, and that various tasks of the construction projects are handled [43]. Kanban with the workflow's visualisation can help the structure of Scrum, optimise the team activities and make shorter meetings [44].

Waterfall: This methodology, also known as Waterfall, can be used in any project and is typical in construction. It is called like this because it has systematic and sequence phases. These phases are a) Requirements specification b) Design c) Construction d) Integration e) Validation f)

Installation g) Maintenance [45]. Even though this methodology tends to be used frequently in construction due to its simplicity in the phases, it fails to adapt the communication and coordination for mega and complex projects [43].

In the literature, several proposed solutions focus on identifying the specific phase during which these challenges can be addressed, such as the pre-construction or planning phase [12]. However, the literature predominantly emphasizes identifying cost overruns rather than pinpointing the precise phase when projects are most susceptible to these overruns. Another recommendation is the application of key performance indicators (KPIs); according to the Egan Report, it is crucial to measure project activities to gain insights into areas requiring improvement. Nevertheless, it is not explicitly outlined which specific areas need enhancement [46]. Additionally, KPIs should encompass project performance and lessons learned. Partnering and collaboration within the industry are also advocated. Reports by Egan, Latham, and Construction 2025 highlight that fostering partnerships, collaboration, and reducing fragmentation can enhance construction practices. However, a report by Beach [47], indicates that the primary obstacle to adopting partnering practices with contractors and subcontractors is resistant clients. Furthermore [48], suggests that implementing a knowledge communication approach could enhance collaboration and efficiency within the construction sector. Other scholars such as [49-51] underscore the necessity of significant investment in organizational behaviour and relationships to cultivate a culture centered on proactivity and diligence, thereby promoting effective resource management in projects.

Moreover, organisations must embrace new technologies. As noted by [52], the Last Planner System (LPS) and scrum methods offer valuable resources for facilitating collaboration and workflow among project participants, thereby supporting transformation, flow, and value. Additionally, employing computer simulation techniques, as suggested by [53], can help identify opportunities to enhance productivity. In the construction industry, a combination of Lean and Agile methodologies appears promising. However [54], argues that Lean's focus in construction should be more project-centric, complemented by Agile to effectively manage change, complexity, and waste elimination. This integrated approach holds the potential to enhance performance, reduce costs, and expedite the delivery of MTPs. Implementing Lean and Agile methodologies necessitates collaboration from stakeholders, as highlighted by [48], and improving communication, teamwork, and organisational culture and structure, as emphasized by [55]. Additionally, customisation and comprehensive utilisation of project management methodologies are crucial. Tailoring these methodologies based on the project type enables organizations and project managers to identify suitable tools, techniques, and risk management strategies. As highlighted in the study by [56], there is no one-size-fits-all approach in project management, underscoring the importance of selecting the appropriate PMM for each project.

Research methodology

This study seeks to identify the challenges associated with MTPs and the project management methodologies employed in these construction endeavours. The research methodology involves a comparative analysis of literature, an e-survey administered to industry professionals, and a case study, aiming to offer additional insights into the implications of employing a framework for delivering MTPs in the UK. The study adopts the Research Onion framework proposed by Saunders, which systematically guides the research process from philosophical underpinnings to data collection in order to address the research objectives effectively (Figure 1). Furthermore, the study aims to test hypotheses regarding challenges and project phases, as well as determine the methodologies utilised in MTPs through the questionnaire.

The foundation of this study lies in combining both inductive and deductive approaches, employing a mixed methods design to achieve distinct objectives. Specifically, the research endeavours to explore existing theories on hybrid methodologies and their application in construction projects based on literature, while also contributing to the expansion of theory regarding hybrid methodologies in MTPs. This study employs a combination of deductive and inductive reasoning, termed abductive reasoning, as proposed by Levin-Rozalis (2004). By collecting quantitative and qualitative data through a survey and a case study, the research aims to validate the framework from multiple

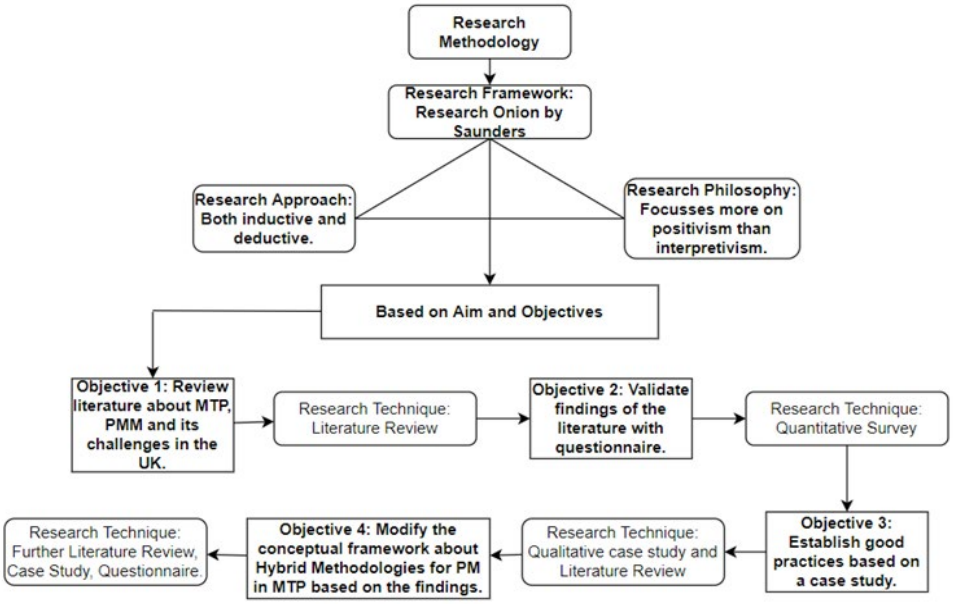

Figure 1: Research Methodology.

perspectives. The inclusion of diverse data sources beyond the literature review is imperative to verify the hypotheses. While integrating multiple research methods in a single study presents challenges such as time constraints, resource limitations, and differing philosophical perspectives inherent in each method, it is argued that employing various research methods enhances the depth, breadth, and credibility of research findings, as posited by [57].

The primary objective involved reviewing existing literature on methodologies employed in construction, particularly in MTPs, as well as identifying challenges and best practices. Subsequently, this literature was validated through a questionnaire administered to Project Managers in the UK. The questionnaire responses were analysed using frequency analysis to ascertain and prioritise the most prevalent themes, including the background and education of professionals, encountered challenges, the impact of these challenges, methodologies utilised, and the project phases in which these methodologies were applied. Additionally, insights into good practices were gleaned from a selected case study. Ultimately, the study culminated in the development of a potential framework for hybrid methodologies tailored for Project Managers, along with implications derived from the findings.

The study's methodology is deemed appropriate for obtaining a comprehensive understanding of the current landscape of MTPs. Employing a mixed-method approach, which integrates both quantitative and qualitative data within a single or multiple studies, allows researchers to validate their findings and enhance confidence in their research outcomes. This method facilitates the analysis and comparison of diverse data types, enabling researchers to reconcile varying perspectives and generalise distinct viewpoints. The resultant framework and identified good practices hold relevance for application in MTPs. However, it is imperative for Project Managers to customise and adjust the framework to suit the unique complexities of their respective projects, as underscored in [56] study, which emphasises that "one size does not fit all projects.

Results

The data for this study was acquired through a questionnaire and a single case study, which were then compared with the findings from existing literature. The analysis of the questionnaire responses was conducted using Microsoft Excel. Descriptive analysis techniques, such as frequency and percentage analysis, were employed for the study. A total of 79 responses were obtained from the e-survey, out of which only 53 were considered valid and fully completed. The remaining 26 incomplete responses were excluded from the analysis. The questionnaire comprised ten questions, encompassing a total of 52 variables. Consequently, the total variables subjected to analysis amounted to 2,756.

Initially, the researcher retrieved the data from the Google Form platform, which was utilised for conducting the survey. Subsequently, the data underwent a purification process, resulting in 53 valid responses. These responses were then manually scrutinised to derive the study outcomes. Each questionnaire item was tabulated to ascertain the frequency count and corresponding percentage. Pivot tables were utilised for data analysis, along with arithmetic operations such as addition, multiplication, and division. The resultant analysis was then presented in the form of tables or figures.

The questionnaire encompassed inquiries pertaining to the types of projects managed by the respondents, revealing that a majority were involved in rail links (58.5%), followed by airports (45.3%), and roads and highways (34%). Additionally, insights regarding challenges faced their impacts, and the utilization of project management methodologies were gleaned from the questionnaire. The subsequent section outlines the questions posed in the questionnaire and the corresponding outcomes.

Question 6B of the research pertains to ranking the challenges encountered in MTPs, and the following were the findings. The complexity of works was chosen by 30.2% of respondents; Risk and uncertainties, by 24.5%; Design changes, by 18.9%; Time delays, by 26.4%; Cost overruns, by 11.3%; Non-performance of subcontractors or nominated suppliers, by 32.1%; Lack of skilled and experienced professionals, by 30.2%; Discrepancy in contracts and conflict between project parties or dependency on imported materials, by 22.6%; Dependency on imported materials or discrepancy in contracts and conflict between project parties, by 26.4%; and Other factors such as unpredictable weather conditions, lack of appropriate software, project fraud and corruption, and unstable government policies, by 41.5%.

Moving on to Question 7B, the objective is to comprehend and compare the literature findings regarding the impact of challenges faced in MTPs as depicted in (Figure 2). It aims to gather insights from Project Managers regarding this aspect in their respective projects. According to the results, 50 respondents (94.3%) indicated that the most common impact of challenges in their previous projects was an extension of the schedule. The second most prevalent impact was an increase in the budget, with 49 responses (92.5%). Lastly, 69.8% of participants highlighted customers' or essential stakeholders' dissatisfaction as a significant consequence. Additionally, 15.1% and 11.3% mentioned a reduction in the quality of infrastructure and termination of the project, respectively.

Question 8B aimed to ascertain the utilisation of PMM by Project Managers throughout the lifecycle of MTPs. According to the findings, 94% of respondents (50) affirmed that PMMs influence the definition, planning, execution, and delivery of MTPs. Conversely, the remaining 6% (3) indicated that PMMs do not impact the life cycle of MTPs. Therefore, the hypothesis stands validated.

Moving to Question 9B, the objective was to comprehend the methodologies employed by Project Managers in MTPs across the UK. The results revealed the most prevalent combinations utilized by PMs (Figure 3): Lean and Agile, cited by 16 respondents; Lean and Prince2, mentioned by 12 respondents; and Lean, Agile, and Prince2, indicated by 11 respondents. These methodologies were either utilized individually or in conjunction with other methodologies such as PMI, APM, Waterfall, Kanban, Scrum, MSP, as well as others including GRIP, CEMAR, in-house methodologies, and RIBA, Oracle Primavera,

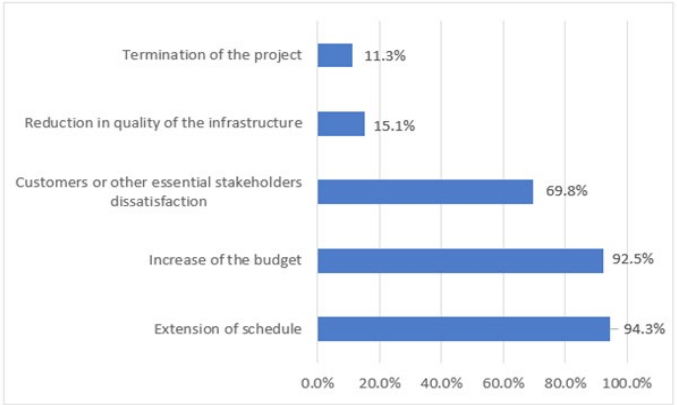

Figure 2: Frequency of the challenges of MTPs (Q7B).

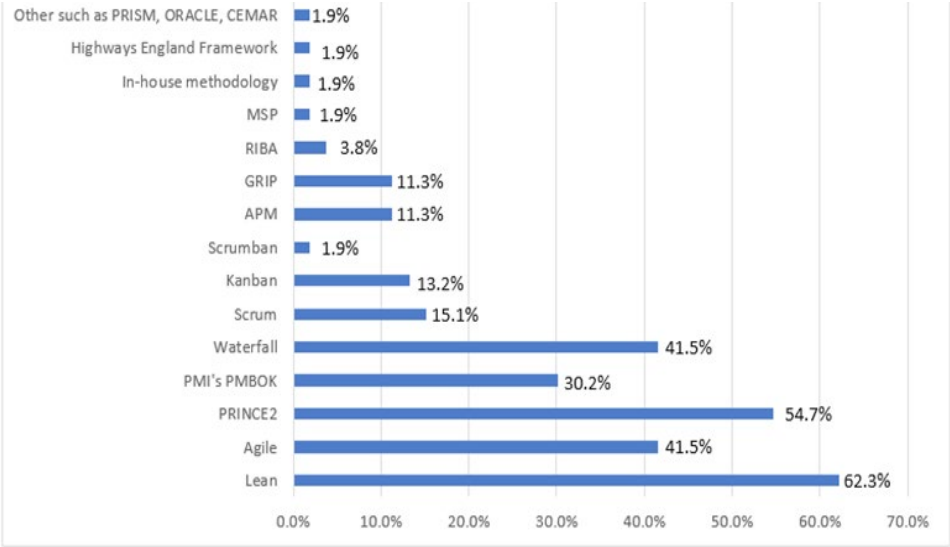

Figure 3: PMM usage in UK MTPs.

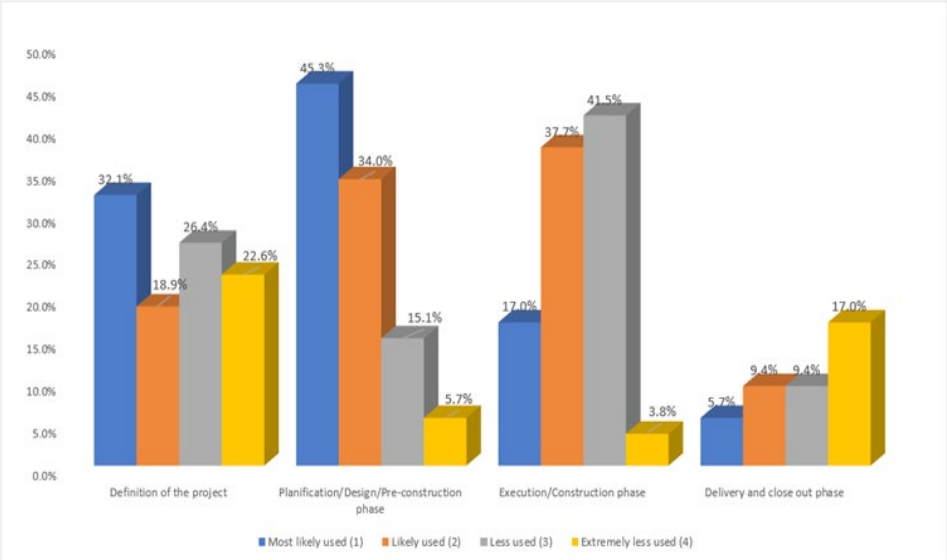

Figure 4: Application of PMM in the lifecycle of UK MTPs.

PRISM. As per the ratings, the most commonly used methodology in the construction of MTPs, with a rate of 62.3%, is Lean. Following closely, the second highest rated methodology is Prince2 at 54.7%, followed by Agile and Waterfall at 41.5%, and PMBOK at 30.2%.

The final question, 10b, aims to ascertain the phase during which project managers predominantly utilise PMM in MTPs. The hypothesis validation involves determining the phase where PMMs are most frequently applied. (Figure 4) presents the outcomes regarding the application of PMM across various life-cycle phases of MTPs. Respondents provided insights on the phases in which they applied PMM, ranked as follows:

- Planification/Design/Pre-construction phase received the highest response, with 24 respondents accounting for 45.3%.
- Execution/Construction phase emerged as the second most likely phase, with 37.7%.
- The Definition of the project phase was less utilised, with 26.4%.
- Delivery and closeout phase were significantly less utilised, with only 17%.

Case Study analysis

The case study conducted by [58] examines a significant construction project under a private finance initiative (PFI), focusing on the enhancement of project delivery through the design and implementation of a mechanical and electrical construction system. This initiative aimed to address the project management constraints effectively. The PMM adopted for this construction supply chain, along with labour strategies, revolves around Lean and Agile principles, forming a hybrid approach known as LeAgile.

Prior to the implementation of this hybrid methodology in construction, several challenges were identified, including low productivity, skill deficiencies within the team, health and safety issues, organisational disarray, and inadequate planning. However, the integration of Lean and Agile methodologies, as highlighted by [59,60], proved to be synergistic and advantageous for both design

and operational aspects within construction supply chains. While Lean principles contribute to enhanced efficiency and cost reduction, Agile methodologies facilitate organizational learning, adaptability, and effective change management [58].

Numerous best practices and techniques were employed to optimise project outcomes, including modular assembly, ABC inventory analysis, ergonomic training for workers, substitution of manual labour with mechanical methods, waste management strategies, implementation of the Last Planner System (LPS), ergonomic workplace design, and provision of suitable tools for the workforce [61].

Discussion

The primary findings derived from both the literature review and the questionnaire are as follows:

- The literature highlights the top five factors affecting MTPs are design changes, risk and uncertainties, inaccurate assessment of project duration, work complexity, and non-performance of subcontractors [16]. The questionnaire results corroborate these findings, ranking the following factors: 1) complexity of works, 2) risk and uncertainties, 3) design changes, 4) time delays, and 5) cost overruns. Additionally, other literature-based factors include lack of commitment from stakeholders, late delivery and lack of coordination and measurement of benefits, and ineffective communication and relevant training [62]. MTPs are widely regarded as controversial, often experiencing delays, exceeding budgets, and delivering less benefit than anticipated [9]. According to [7], the most common challenges in large infrastructure projects are cost overruns [10] and shortages in skills and labour. These challenges result in schedule overruns [11], budget estimations increase [12], low productivity, and can impact performance management and stakeholder interests [13]. Consistent with the questionnaire findings, 28 respondents (52.8%) indicated that the typical impacts of these challenges in their projects include budget increases, schedule extensions, and dissatisfaction among customers or other key stakeholders.

- One potential solution to address these challenges and improve project success is the application of PMMs. Research by [19] suggests that implementing PMM can contribute to modifying project success by 22.3%. Moreover, the comprehensive application of PMMs has been shown to enhance project success. The analysis revealed that the majority of respondents (94% of 50 out of 53) confirm the fundamental role of project management methodologies throughout the lifecycle of MTPs. Among the most commonly used PMMs in construction are Lean, Agile, the hybrid LeAgile methodology, Scrum, Scrumban, PMBOK, APMBOK, and Waterfall [63].

- In the survey, the predominant combinations of methodologies applied to MTP were Lean and Agile (16 respondents), Lean and PRINCE2 (12 respondents), and Lean, Agile, and Prince2 (11 respondents). These methodologies were either used individually or combined with others such as PMI, APM, Waterfall, Kanban, Scrum, MSP, as well as in-house methodologies like GRIP, CEMAR, RIBA, Oracle Primavera, and PRISM.

- Literature supports the effectiveness of hybrid methodologies like Lean and Agile in construction, as highlighted by various authors such as [32-35]. These methodologies synergise to enhance efficiency, reduce waste, increase value, and manage complexity effectively. While there is limited literature on the suitability of PRINCE2 for construction projects, the survey indicated its application in UK construction projects.

- Other methodologies commonly used in the UK construction industry include Highways England's in-house Project Control Framework for projects related to the strategic road network [64]. Projects typically progress through four or five phases, such as project definition, planning/design/pre-construction, execution/construction, delivery and closeout, and sometimes maintenance. Planning is emphasised as a high priority in project management, with the execution phase being another crucial aspect based on the planning. The survey results indicate that most participants utilize PMMs during the planning/design/pre-construction phase (45.3%), followed by the execution/construction phase (37.7%).

- In the presented case study [58], advocate for the implementation of Lean and Agile methodologies in extensive and intricate projects, exemplified by the electrical and mechanical project undertaken in a hospital setting in the UK. The adoption of these methodologies yielded substantial benefits, including enhanced productivity, increased value, and minimized waste throughout the construction process. Furthermore, the literature underscores the significance of stakeholder partnership and collaboration within the industry, as emphasized by [48]. Another recommended best practice involves the utilisation of key performance indicators (KPIs) to assess and oversee project progress and facilitate knowledge transfer, as suggested by [65]. Additionally, effective communication, teamwork, and the transformation of organizational culture and structure are vital components to complement PMMs, as highlighted by [55]. Embracing new technologies, such as the Last Planner System (LPS) and other tools inherent in methodologies, is also advocated [52]. Ultimately, organisations are urged to tailor, customize, and comprehensively utilize project management methodologies to suit their unique contexts, as emphasized by [56].

Thus, the conceptual framework underwent adjustments to align with the commonalities observed in the validation process involving the questionnaire, case study, and literature review. It furnishes crucial insights for managing MTPs and serves as a compass for identifying the prevalent hybrid PMMs. Consequently, PMs can tailor and refine this framework to suit their specific project needs. Moreover, they can leverage appropriate tools from Lean and Agile methodologies, taking into account project characteristics, complexity, and risks.

The Hybrid Project Management Methodologies equip PMs with a repertoire of tools and techniques to navigate project management effectively throughout the project life cycle. By adopting a systematic, well-planned, and adaptable approach, such as the application of LeAgile, coupled with robust communication and stakeholder support, PMs can enhance the likelihood of delivering projects within designated timelines and budgets. Additionally, emphasizing risk management is pivotal for identifying, mitigating, and rectifying complexities inherent in such projects.

The framework, depicted in (Figure 5), exclusively emphasizes the utilisation of agile and lean methodologies for managing and executing MTPs. By focusing on these methodologies, PMs can streamline project management efforts and concentrate on core project aspects. While the previous conceptual framework incorporated additional methodologies like Scrumban and Kanban, the questionnaire and case study revealed minimal adoption of these methodologies among respondents. Therefore, it is advisable to comprehensively implement methodologies such as the blend of Lean and Agile within an organization to enhance project success, rather than employing multiple methodologies concurrently in a supplementary manner, as suggested by [19]. Furthermore, the framework includes an additional

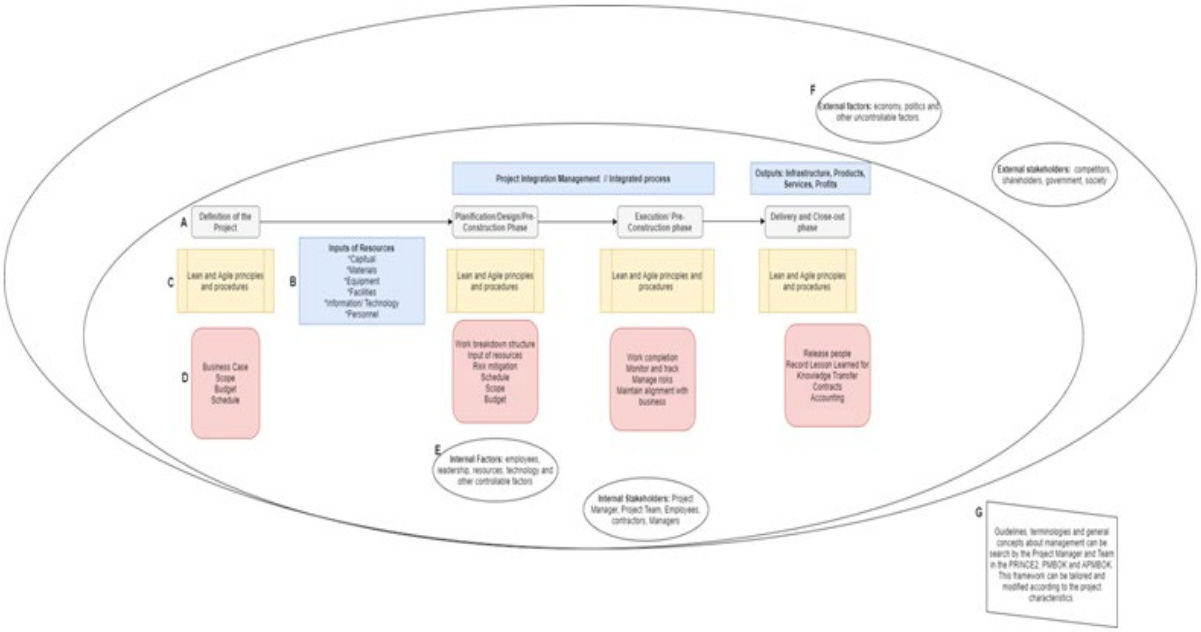

Figure 5: Proposed Hybrid Methodology Framework.

guideline, PRINCE2, alongside PMI and APM methodologies. Although conclusive evidence regarding its application in construction or engineering projects is lacking, the questionnaire findings indicate widespread use of PRINCE2, along with other PMMs, in MTPs within the UK context. Whereby:

- Part A of the Framework delineates the project lifecycle, which is contingent upon the project type and may include additional stages such as maintenance for certain MTPs. It is imperative for MTPs to define their lifecycle phases from the outset.

- Part B illustrates the Inputs, Project Integration Management, or integrated processes, and the outputs. Identifying project inputs occurs during project definition and is refined during planning to ascertain necessary resources. This segment is pivotal as it requires the PM, team, and stakeholders to assess crucial project elements such as finances, machinery, equipment, and other resources. The Integrated Process encompasses execution aligned with planning, necessitating the consideration of strategies like Risk Management, Change Management, and Configuration Management. It is essential to document knowledge during this phase and establish a knowledge management process to retain operational insights. Project output signifies project delivery and closure, with maintenance potentially included. During this phase, the project manager should prompt the team to document lessons learned and best practices for future projects as part of knowledge management.

- Part C illustrates the amalgamation of project management methodologies applied across different phases, based on the most prevalent ones identified in both literature and the questionnaire. For MTP construction, it is advisable to embrace LeAgile principles and processes such as waste management, Last Planner System (LPS), change management, and valuing team perspectives, among others applicable to the project.

- Part D outlines potential activities for each phase, which may vary depending on the project or organisation.

- Part E enumerates common internal factors and stakeholders of a project, which can differ based on the organisation.

- Part F identifies typical external factors and stakeholders of a project, which may vary depending on the organisation.

- Part G serves as a reminder for PMs to leverage and expand their knowledge using guidelines and terminologies from PRINCE2, PMBOK, and AMPBOK from the literature. Additionally, they can explore other methodologies and tailor them to their projects based on their unique characteristics.

Conclusion and recommendations

This research introduces a Hybrid Methodology Framework designed to suit the execution of Mega Transport Projects (MTPs). Given the contentious nature of MTPs, stemming from their inherent risks and complexity, this study contributes significantly to the existing literature on Project Management Methodologies (PMMs). The results underscore that Project Managers (PMs) can effectively tackle the challenges associated with MTPs by employing hybrid project management methodologies alongside other best practices. Moreover, PMs have the flexibility to tailor these methodologies to align with the specific complexity and nature of each project.

Particularly, the combination of Lean and Agile methodologies has proven effective in the construction of MTPs, complemented by established project management frameworks such as PMBOK, APMBOK, or PRINCE2 for certain aspects. However, it's worth noting that PRINCE2 lacks focus on specialised techniques such as motivation, delegation, and team leadership (people management), as well as planning techniques like Gantt charts and critical path analysis, risk management, budgetary control, earned value management, and quality management, as noted by [66,67]. Additionally, leveraging project management tools such as LPS, computer simulations, and technologies like BIM, modularisation, and offsite construction, alongside fostering collaboration and effective communication, are considered best practices. Research suggests that PMMs contribute to approximately 23% of project success [19].

In general, the UK Construction sector must embrace continuous improvement and strive to overcome fragmentation. Reports emphasise the need for the industry to adopt a more proactive and collaborative approach throughout its structure. Knowledge transfer is deemed essential and applicable to MTPs. The typical procurement process in UK civil engineering contracts follows a design-bid-build approach. However, it's crucial for the industry to assess the suitability of this method for large and complex projects, considering the trade-offs involved in physical design and construction methods [68]. Furthermore, the construction sector should prioritise addressing issues highlighted in various construction reports, including fragmentation, lack of trust, and unity [69-71], while striving to improve project delivery within organisational constraints. There is a need for increased knowledge sharing within the industry, particularly regarding the performance of specific PMMs applied in projects and their impact on project success. Organisations can further enhance project success by customising hybrid project management methodologies to align with their business processes.

The implementation steps for this framework involve the PM defining the project's lifecycle. The framework currently consists of four phases (Definition of the project, Pre-construction or design phase, Construction or execution phase, Delivery, and close-out of the project), but it can vary depending on the project, with some MTPs including a maintenance phase. Following the project definition, detailing its inputs becomes crucial, initiating the planning and definition of activities, schedules, personnel, and budget.

From the outset of the project's life ycle, it's essential to integrate principles from hybrid methodologies such as Lean and Agile. Particularly, Lean methodology is recommended for waste reduction and process improvement during construction, while agile methodology allows for early identification of customer requirements and task division involving team collaboration. Various Lean and Agile techniques and tools should be applied in each phase. Essential Lean tools applicable to construction include Just-In-Time, Value Stream Mapping, Bottleneck Analysis, Plan-Do-Check-Act (PDCA), Last Planner System (LPS) [52], Root Cause Analysis (RCA), and Overall Equipment Effectiveness (OEE) [72]. Agile practices commonly involve project inspection, customer focus, waste elimination akin to Lean, planned events, team reviews, and supportive systems to optimise work [73]. These elements can be utilized in conjunction with those outlined in section D of the framework.

Throughout the project, the PM, along with the team, should continuously analyse and evaluate risks derived from internal and external factors, employing timely preventive or mitigating measures [16], and referring to guidelines and best practices outlined in PRINCE2, PMBOK, and APMBOK. The PM may incorporate additional elements and methodologies as deemed suitable and necessary for the MTP.

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