4P Delays in Project Management

Abstract

Purpose - As a result of the increasing challenges of time overrun, several companies regularly set up delay assessment procedures for performance improvement and profit maximization. In the construction industry, projects are enormously complicated and involve significant budgets, and therefore optimizing project performance through the root cause analysis should be imperative for every project manager. Typically issues of delays in projects are generally discussed and problematized separately, yet a comprehensive framework for systematic analysis and grouping of delays is rarely contended. In this article, the 4P concept (Project Related, Practices, Participants and Procurement) has been introduced for identifying, analyzing and classifying delays in the internal environment of the project development process.

Design/Method/Approach - The 4P conceptual framework was validated through the synthesis of the existing literature.

Findings – Interestingly despite the increasing concerns about delays in the construction industry, most research on delays are project and/or country specific, thus no consensus about the sources of delays. The application of the proposed concept as a theoretical framework would provide an understanding of the available delay sources, their risks and use for project delay assessment and classification.

Research limitations/implications – This study grouped delays based on shared characteristics and four main sources were identified and analyzed. There may be other sources or factors, yet would be dependent or aspect of the 4P.

Practical Implications – Informs project teams to reduce delays in the construction industry.

Originality/value – Application of risk assessment tool to conceptualized delays in the internal project environment.

Keywords: concept, delay sources, project, 4P, risks

Introduction

Delay is often described as the time overrun beyond a project completion date. It could be said to be a failure of a project to be completed within the agreed schedule. Even though the magnitude level varies considerably across projects and geographical boundaries (Sambasivan & Soon, 2007; Shehu et al., 2014; Sorooshian, 2014), projects undertaking in the construction industry experience some form of delay (Ansah et al., 2016a; Ansah and Sorooshian, 2017; Norzima et al., 2011). Meanwhile, these delays occur at different stages, from project conception through completion to maintenance; yet, most delays occur at the execution phase (Norzima et al., 2011; Sorooshian et al., 2010).

Delays can create a huge cost and serious problems to all the concerned parties and even the health of the economy (Sambasivan et al., 2017; Shehu et al., 2014). In this regards, it is very essential for project managers and professionals to recognize the need to understand the main sources of delays in order to deploy practical strategies to mitigate and reduce the effects and risks resulting from delays (Ansah & Sorooshian, 2017). Time and cost are the two main concerns (Elbeltagi et al., 2016), with cost often seen as an outcome of the time (Manley & Chen, 2016). Minimizing cost and time overruns could effectively be achieved through identification and classification of the real causal factors of delays in the construction industry (Ansah et al., 2017; Norzima et al., 2011; PMI, 2004; Sorooshian, 2014). Also, the parties that are responsible for such delays ought to be identified in order to trace delay sources at different phases of the project and within any of the project parties so that issues relating to responsibility and its necessary measures could be effected.

Projects are enormously complicated in nature and often involves significant budgets, and therefore reducing delays in the project development cycle should be imperative for every project manager (Sambasivan et al., 2017). According to Bing et al. (2005) and Patel et al. (2013), project involves different interested groups and parties who have expertise, different stake and value system, and desired outcome and therefore requires critical assessment to avoid projects failures (Aziz, 2013; Norzima et al., 2011; Sorooshian et al., 2010; Sorooshian, 2014, 2015).

Many organizations have turned out to be more proactive and aware of utilizing delay or risk analyses techniques as a part of project development strategy (Hwang et al., 2016; Hwang et al., 2017). In like manner, delay assessment and control have become a timely issue generally discussed across organizations. In any case, this is different with

respect to the construction sector (Klemetti, 2006). This contradicts the fact that the sector is endeavoring to be more time and cost efficient and at the same time have more projects under control.

Although several techniques and methods for identifying, analyzing and classifying delays in projects have been developed and generally discussed among researchers and across organizations, a comprehensive framework for systematic analysis and grouping of delays in construction projects is rarely contended.

Among the concept which is broadly used for delay/risk management is risk management process which comprises of four primary steps: identification, assessment, action, and monitoring. There are various techniques and methods in each of these steps, which facilitate handling of the risks and its resultant delays (Cooper & Grey, 2005; Ansah et al., 2016). Other methods for analyzing delays in projects include critical success factors analysis (Saqib et al., 2008; Salleh, 2009), scheduling impact analysis or time impact analysis (Arcuri et al., 2007), etc. These techniques are worthwhile, yet, there seems to be a gap with respect to delay assessment and management techniques in construction projects. This paucity relates to the fact that there has been surprisingly little academic and empirical research on the area discussed in this paper and much of what have been written about construction project delays are project or country specific, or description of risks, or few causal factors of delays, without a comprehensive technique for overall delay identification and groupings. In essence, despite the scientific progress in the understanding of delay sources, there is a scarcity of empirical study on its identification, classification, and assessment in the project development cycle. The stimulating point here is that without a comprehensive understanding and systematic analysis of delay sources and their individual risks, reducing delays and optimizing the performance of projects will be complicated. Also, there seems to be a lack of consensus among researchers and industrial practitioners about delay sources and its groupings (Norzima et al., 2011; Sorooshian, 2014).

In filling this gap, this paper validates a systematic conceptual technique known as the "4P concept" (Project Related, Practices, Participants and Procurement) to identify, analyze and categorize delay sources in the internal environment of the project development process. The conceptual technique validated in this paper is intended to offer an understanding and provide valuable insights for researchers and stakeholders on the delay sources and its' categories. Thus, this would help project parties appreciate delay sources and devise strategies to mitigate them, thereby, leading to a significant

process for project objectives achievement, in terms of time, cost, quality, and minimize the percentage of the failure in construction projects. Explicitly, the knowledge gained from this study would equip stakeholders, improve project delivery, and if well understood, would lead to a better performance and contribute to the knowledge and practice of delay control in the project environment as a whole.

The remaining sections are organized as follows: the next sections focus on the research method/approach and sources of delays, and this is followed by the types of delays. The other sections present the concept of the 4P, assessment of 4P and the types of delays and conclusions respectively.

Research Method/Approach

The 4P conceptual framework was validated through the synthesis of the existing literature. In order to identify the relevant articles for this framework, we conducted a systematic analysis of project development factors that influence time overruns. The study followed the systematic method introduced by van de Vijver (2009), including journal/article selection, and reference search. First, data from medium to large projects was gathered from peer-reviewed journals, conferences and other databases within the civil engineering, construction management, project management, technology management, architectural management, built environment, etc. Although there are wide and varied views about medium or large projects and most definitions are organization or country specific, medium or large projects have normally been defined based on the complexity of the project. The complexity assessment takes into account all the conventional project management areas (schedule, scope, quality, budget, resources (human and equipment), risks, etc.) (Haider and Haider, 2012). The researchers considered four factors and these included time, budget, requirements and flexibility. Hence, a medium project is defined as project with three to six months schedule, $250,000-$750, 000 budget, schedule flexibility, clear requirements, etc., while as a large project is defined as project with more than six months schedule, more than $750,000 budget, aggressive schedule, undefined requirements, etc. (Haider and Haider, 2012; Hass, 2010).

Gathering such information from both public and private sectors' projects or collaborative projects (PPP) required due diligence and lots of circumspection because existing literature on delay analysis are often project-specific or country-specific. Next, we analysed the titles, table of contents and the content by examining the abstract or

introduction, the scope or method, the conclusion or sometimes discussion sections (Bemelmans et al., 2012; Spina et al., 2013, 2016). It is contended that the real contributions would probably be found in the leading journals and to identify relevant articles, it is key to examine the table of contents of the journal (Bemelmans et al., 2012; Spina et al., 2013, 2016; van de Vijver, 2009).

Also, to ensure the comprehensiveness of the concept, this study examined the references made by the authors to determine if those articles have relevant contributions (van de Vijver, 2009). Similarly, this study examined the impacts of the selected journals (prior to 2016). Emphatically, 17 ISI (Web of Science), 28 Scopus, and other individual articles or books with impacts (citations) relevant to the study were selected. By doing this we could recognize the originality, contribution, and the domain specific works. This resulted in the selection of 73 articles relevant to the study (see reference list). Finally, the study identified the sources of the delays and then further identified the individual risks associated with the sources. The risks or delay factors were then categorized into main sources based on shared characteristics. The review and synthesis are limited to relevant literature within the context of delays assessment methods in the internal environment of construction projects.

The Internal Sources of Delays

The frequency of the ability or the inability of construction projects to be completed on time and within budget mainly rest on the project parties. This is because successful construction projects are the result of multiple effective and quality decisions made by contrasting team members (Ansah et al., 2016a). Project teams and their decision-making processes, operations, administrative processes, experiences, skills and employed tools must be assessed to improve the likelihood of projects succeeding. Industry studies have revealed that meeting client's requirements are firmly impacted by the effectiveness of the project team.

The internal sources of delays occur due to the malfunctions of any of the project parties including the designers, architects, client, contractor and other parties that provide labors, materials or services. For instance, the main sources of delays related to the client in Saudi Arabia included factors such as; work suspension, financial problems, change orders, material approvals delays, slow decision making, and low technical submittals. Also, delays related to the contractor comprised; less qualified and inexperienced technical staff, problems associated with financing projects, inter-party conflicts, etc.

More also, delays related to consultants included inexperienced and lack of staff for design documents review. Material related delays included unavailability of materials and poor procurement systems. Furthermore, labor-related delays comprised of unavailability of manpower and low level of skills. Lastly, unrealistic timeframe was identified as the root source of contractual relationship and contract disputes (Al-Kharashi & Skitmore 2009; Mpofu et al., 2017).

The survey reports by Abd El-Razek et al. (2008) in Egyptian building construction industry indicated that the overall important factors causing delays included contractor's financial difficulties, delays in payment or partial payment, changes in design by the owner or his representative, and ineffective construction/contracts management. Also, from the studies of Mamman & Omozokpia (2014), unavailability of experienced and qualified personnel, poor quality of raw materials and equipment, non-conformance to specification and timeline, unavailability of resources, average delays by owners in making payment, poor information coordination among clients and project parties, and high cost of material and equipment were among the causal factors adversely influencing construction projects performance in Niger State, Nigeria. Similarly, lack of funds, changes in drawings, inadequate information from consultant, slow decision making process by the client, ineffective communication among project parties, inconsistencies and mistakes in contract documents, nonpayment of completed works, fluctuations of building material prices were found among the factors causing delays in construction projects delivery time in Nigeria (Owalabi et al., 2014). In South Africa, it has been contended that the key significant factors hampering the success of project delivery are quality and attitude to service (Mbachu & Nkado, 2007). Frimpong et al. (2003) undertook a survey on time and cost overruns of Ghanaian groundwater projects and their findings concluded that inefficient management of contract, low technical competence, and escalation of material prices as the major factors causing the overruns.

The findings from Iyer & Jha (2006) found among other factors including project participants interactions, competency of owners, inter-project participants conflicts, social and economic hostilities, conditions of the weather, unawareness, and lack of information, and aggressive competition at the tender stage as factors affecting the performance quality of projects in India. However, in 2013, the survey by Megha & Rajiv (2013) revealed a new trend in the factors causing delays in India. Out of the 59 factors causing delays identified under 9 major groups, the results indicated a total of 10 main factors; out of which 5 were ranked as being common by the methods used for ranking (i.e. relative

index for importance and index for importance which was based on the level of severity and the level of frequency). These 5 included; short contract duration, unavailability of labors, material delivery delays, low level of labors' productivity, and delays by the owners in progressive payments.

A survey conducted by Salunkhe & Patil (2014) on large construction projects in India sought the views of project implementing agencies, clients, contractors, and consultants. Delays associated with the project implementing agencies included land acquisition delays, contractor's mobilization delays, specification revision delays, problems with funding; among others. Delays associated with the client were changes in the scope of work, payment issues for completed works, low technical capabilities, and others. The delays caused by contractors were poor scheduling and planning, low level of experience and poor making decisions, etc. Likewise, delays caused by consultants comprised of specification revision delays, low level of coordination between consultants and contractors, among others.

In Jordan, 130 public projects including school buildings, administration and office buildings, communication facilities and medical centers were examined by Al-Momani (2000). The findings concluded that changes made by users, adverse climate, poor site conditions, delays in deliveries, and poor economic conditions were among the factors causing delays in Jordanian's construction projects. It was also observed that there was a strong correlation between the delay factors and contractor's failure and ineffectiveness in performance. Ogunlana et al. (1996) carried out a comparative study in Bangkok, Thailand on time and cost overruns. It was confirmed that in developing nations the problems facing construction industry can be clustered into three layers; shortages of resource supply, problems with clients and his representative(s) (consultant), and contractor's incompetence.

A report by Saqib et al. (2008) ranked 77 variables influencing project implementation success in Pakistan. The report listed critical success factors (CSFs) including timely and effective decision making, project manager's experience; contractors cash flow, the experience of contractors, supervision, and management of site, prior experience of the project manager, client's decision-making capabilities. Nonetheless, Haseeb et al. (2011) reported that in Pakistan, problems in payments and finance, poor site planning and management, material and equipment shortages were most general factors causing delays.

It was indicated that in Singapore the Housing and Development Board for the past two years has given time extension to about 36 failed projects. The reasons for such projects delays were design changes, shortage of foreign labors, among other issues (Ansah et al., 2016b). Also, reports on government contract projects in Malaysia confirmed that about 17.3% of 417 projects were considered sick with more than three months delays or abandoned (Shehu et al., 2014). A review conducted on the Bakun hydro project revealed an unsatisfactory performance following a one to three-time extension ranging from 555 days to 1403 days given to the contractor (Othman and Ismail, 2014). Furthermore, according to Othman & Ismail (2014), the Refinery and Petrochemical Integrated Development (RAPID) which is expected to start operation in 2016 would only be operative in 2017 as a result of some delay issues. Besides, a report from Aftab (2014) indicated that in Malaysia, only 20.5% of public projects and 33.35% of the private sector projects were able to be completed within time as planned in 2014. Emphatically, Memon et al. (2011) strongly argued that time overrun is one of the critical issues confronted by the Malaysian construction industry. He reiterated that in contrast to the main project stakeholders, numerous projects in Mara experience extensive time overruns and this problem is more obvious as projects mostly exceed the initial time and even cost estimates (Memon et al., 2014).

The findings of Faridi & El-Sayegh (2006) established inadequate manpower skills, inefficiencies in both supervision and management of site, poor leadership, unavailability and equipment breakdowns, delays in drawings preparation and approvals, slow process in decision making by owners, contractors' financial problems, incomplete drawings or documents or specifications, lack of planning, unavailability of manpower, skills and materials, poor supervision and management of site, and delays in progressive payments of finished works, as the major factors contributing to delays in UAE's construction projects.

Salleh (2009) concluded that the factors causing Brunei construction industry's delays consisted of ineffective communication among project parties (owners, contractors, and engineers), slow decision-making process and regular changes in orders by owners, ineffective planning and lack of experience by the contractor, issues relating to payments of finished works, and lack of subcontractors experience. Manager's experience and abilities, project's scope clarity, the definition of work, the use of control systems, commitment to goals by the project manager, motivation of project teams, adherence to

safety requirements and procedures were some of the findings asserted to be crucial in the avoidance of delays which are critical to the industry.

All these studies confirm in one way or the other that there are serious challenges in the construction projects. Also, these problems are generated from different sources and may occur at different stages in the project construction (right from inception to completion and even sometimes maintenance period).

Types of Delays

In order to establish comprehensive understandings of delays, this paper addresses the types of delays and further analyze the synergy between the types and sources of delays in the proceeding sections. There are four main types of delays in terms of their operation contractually (Alaghbari et al., 2007; Ansah et al., 2015; Arcuri et al., 2007; Tumi et al., 2009) and a delay source identified in this paper may have more than one type of delay. These types include **Compensable Delays** (Al-Aghbari & Mohammed, 2005; Arcuri et al., 2007; Tumi et al., 2009; Umair et al., 2014), **Excusable/Non-compensable Delays** (Al-Aghbari & Mohammed, 2005; Arcuri et al., 2007; Tumi et al., 2009; Umair et al., 2014), **Non-Excusable Delays** (Alaghbari et al., 2007; Arcuri et al., 2007; Umair et al., 2014) and **Concurrent Delays** (Al-Aghbari & Mohammed, 2005; Arcuri et al., 2007; Umair et al., 2014).

Compensable Delays

These delays are basically generated by the owner and his representatives. Errors in designs, drawings, and specifications are the most cited examples of this type of delay. Delays of this nature may arise when the owner or his representative fails to respond on time to a request made for drawings or information or payments, interruptions, and interference by the client, material, design or specification changes by owner, among others. This type of delay entitles the contractor to both additional time and budget (Al-Aghbari, 2005; Arcuri et al., 2007; Tumi et al., 2009).

Excusable/Non-compensable Delays

This type of delay is normally called “Force Majeure,” meaning “chance or unavoidable occurrence.” It is also known as the “acts of God” because it is caused by nature and none of the project parties are responsible for its occurrence. In procurement, contractual and some legal agreements, there are clauses for “Force Majeure” that allow a time extension

for contractors should in case these unforeseen circumstances delay a project. Even though time extension is allowed but according to Arcuri et al. (2007) and Tumi et al. (2009), there is no additional budget given to the contractors. Examples of these delays may include hot and cold temperatures, rain, flooding, a volcanic eruption, earthquake, among others.

Non-Excusable Delays

Generally, the contractors and his subcontractors or suppliers are the causal parties involved in the generation of this type of delay. There is to an extent some entitlement in the form of compensation to the contractor from the subcontractor or the supplier if the delays are caused by them. The contractor receives no additional budget and time or entitlement from the owner, however, through compensation or work acceleration, the contractor has to make it up to the client or the owner (Alaghbari et al., 2007; Arcuri et al., 2007).

Concurrent Delays

This type of delay usually occurs in a situation where two or more delay factors or types overlap at the same time. For instance, when excusable and non-excusable types of delays occur at the same time, the resulted delay is a concurrent delay (Arcuri et al., 2007). Conflicts between the client and contractor may arise from this type of delay as excusable delay entitles the contractor for additional time but the client may turn down his request because of the non-excusable delay (Alaghbari et al., 2007; Arcuri et al., 2007).

Discussion

Despite the increasing concerns about delays in the construction industry (Jiang & Lu, 2017; Fertitta et al., 2016), most research on delays are project and/or country specific, thus no consensus about the sources of delays (Ansah et al., 2016b). The application of the proposed concept as a theoretical framework would provide an understanding of the available delay sources, their risks and use for project delay assessment and classification. As comprehensive as it may be, there may be other sources or factors, yet would be dependent or aspects of the 4P.

The Concept of 4P Delay

It is evident from the existing literature that even though project are completed faster than before, today's construction industry faces more challenges than before (Assaf & Al-Hejji, 2006; Iyer & Jha, 2006; Faridi & El-Sayegh, 2006; Lowsley & Linnett, 2006; Sambasivan & Soon, 2007; Alaghbari et al., 2007; Memon et al., 2011; Memon et al., 2014; Aftab, 2014; Shehu et al., 2014; Sambasivan et al., 2017). Also, there are different views on the sources of these challenges and their subsequent delays among researchers (Norzima et al., 2011; Sorooshian, 2014). Explicitly, the body of literature related delays/risks assessment lacks cohesion and integrated focus, and the need to systematically assess, locate and develop comprehensive delay assessment framework within the internal project environment is not adequately addressed.

The internal sources usually emanate from the project parties and these may include the clients, engineers, designers, consultants, contractors, subcontractors, suppliers, manufacturers, among others. Based on thorough literature review, these sources are clustered into four (4) main delay sources known as the "4P" (Ansah et al., 2015) including **Project related, Practices, Participants,** and **Procurement.**

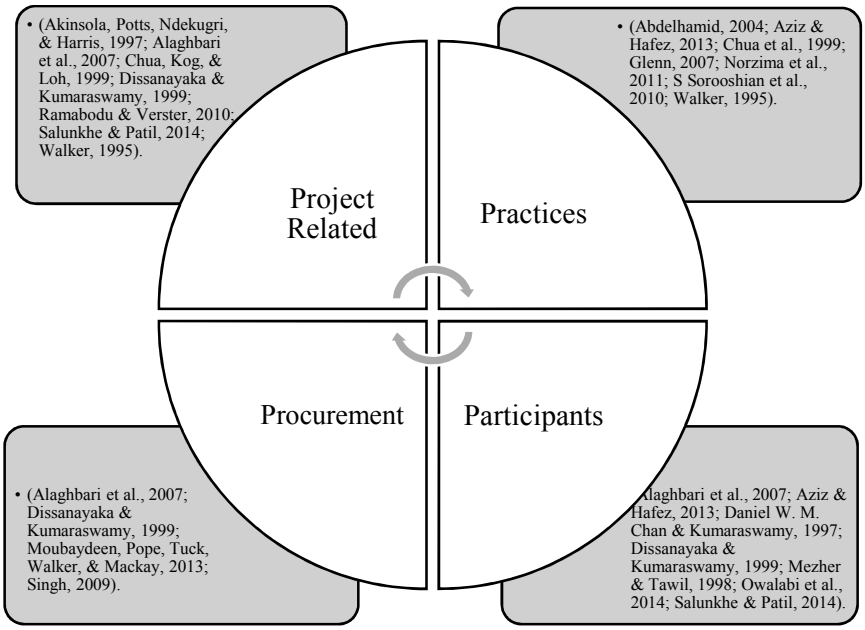

Figure 1. The 4P

Project Related

This source includes health, safety, internal project issues and the project scope. The elements for evaluating this source are the project's type, the project's nature, the project's

size, the project's complexity, health, and safety, and site layout (Alaghbari et al., 2007). These attributes may cause time and cost overruns if not regulated effectively. For instance, the most useful tool for predicting time is the scope of a project (Walker, 1995) and several researchers have confirmed the impact of the scope of the project (Akinsola et al., 1997; Dissanayaka & Kumaraswamy, 1999; Chua et al., 1999; Ramabodu & Verster, 2010). It is the anchoring element of every project and other variables including budget, estimation, quality, plan, and schedule, are heavily dependent on the project scope. Therefore, there is the high tendency of project failure should any adjustment, alteration, and omission occur in the scope of a project in the execution stages. In such circumstances, the laid out plan for the project would have to be assessed and modified and this might come with its own schedule and budget (Walker, 1995). The major risks in this source include including change of budget, change of estimation, change of quality, change of plan, change of schedule, accidents, poor work layout and other safety concerns. It is, therefore, keen for project managers, clients and all the parties involved in a project to effectively regulate and stick to the safety standards and project scope as its changes may result in change orders and eventually lead to cost and time overruns (Salunkhe & Patil, 2014).

Practices

Generally, contractors are expected to complete projects within the specified time as agreed upon (Sorooshian et al., 2010; Norzima et al., 2011). They should apply skills, tools, experience, among others, to accelerate project completion within the contract duration (Glenn, 2007; Sorooshian et al., 2010). However, the current practices of project management reveal a different trend where delays in construction projects have been attributed to the failures of the traditional construction practices (Norzima et al. 2011; González et al. 2015; Gibbs et al., 2017). The practices of the conventional methods have failed to deliver projects on time (Abdelhamid, 2004; Aziz & Hafez, 2013). In essence, the traditional project delivery system which focuses on tasks or critical path method for planning and controlling work does not optimize projects but only pieces (González et al., 2015).

The various risks in the current project management practices include poor feedback capabilities, poor decision-making, and coordination, poor communication, poor troubleshooting skills, lack of experience, ineffective monitoring, scheduling and planning, use old technology, lack of technical know-how, lack of managerial support and

actions, among others (Walker, 1995; Chua et al., 1999; Norzima et al., 2011; Gibbs et al., 2017; Birgonul et al., 2015). Others may also include lack of health and safety programs, poor monitoring of subcontractors' works, etc.

Participants

The main participants in a project are Client/Owner, Contractor, Consultant, Designer/Engineer, and Subcontractor or Supplier (Alaghbari et al., 2007; Owalabi et al., 2014; Salunkhe & Patil, 2014). These sources could further be categorized into Client Related Sources, Consultant Related Sources, Design Related Sources, and Contractor Related Sources. Generally, the risks in the **Client Related Sources** include lack of knowledge and experience, type of client (public, semi-public, private, etc.), financial and payment problems, inadequate skills in managing projects, lack of risk aversion skills, mistrust towards the project team, etc. (Chan & Kumaraswamy, 1997; Dissanayaka & Kumaraswamy, 1999; Ansah et al., 2015; Sambasivan et al., 2017). Also, joint ownership conflicts, change orders, design documents approval delays, problems in funding resulting in delays in progressive payments, low level of technical staff, work suspension by owner, method of tendering or bureaucratic processes in bidding, unqualified contractor selection, owner's low level of experience, interference, ineffective coordination and communication between client and the contractor, just to mention a few (Aziz, 2013; Owalabi et al., 2014; Salunkhe & Patil, 2014; Birgonul et al., 2015).

Again, the risks in the **Consultant Related Sources** include low level of experience, scope changes, testing and inspection delays, inefficient site investigations, design documents reviews and approvals delays, ineffective communication between consultant and contractor, frequent disputes with design engineers, etc. (Birgonul et al., 2015; Aziz & Hafez, 2013). Also, the risks in the **Design Related Sources** are omissions and errors in design, low level of experience, low level of modern design software usage, incomplete and defective designs, misunderstanding or misinterpreting of client's requirements, etc. (Aziz, 2013; Chan & Kumaraswamy, 2001; Chan & Kumaraswamy, 1997; Salunkhe & Patil, 2014)

Finally, the risks in the **Contractor Related Sources** are inadequate experience, use of obsolete technology, project team's incompetence, poor coordination and communication between contractor and client or consultant, inefficient supervision and management of site, errors in works, reworks, poor scheduling and planning, etc. (Aziz, 2013; Aziz & Hafez, 2013; Owalabi et al., 2014).

Procurement

The procurement systems in the construction industry have been an area of immense interest and intense debate. This is because procurement is at the center of the industry as it brings the resources, both the team for managing the resources or building the project, and the material resources needed throughout the project development cycle. Procurement is the system through which the construction industry secures and carries about projects (Ansah et al., 2015). However, there have been concerns about problems associated with the type of procurement, risk allocation, procurement methods for design and the procedure for projects and tendering (Burke & Harris, 2016; Alaghbari et al., 2007; Bing et al., 2005). The tendering processes of PPP have more complications and require strict evaluation and structuring of tendering process and the awarding method. The risks in this source are labor and skill shortages (Ho, 2016), unavailability of materials and its price escalation, poor supervision and management of materials, poor material procurement, selection of unqualified contractors, subcontractors and suppliers, materials delivery delays, funding problems, poor estimations and bidding, unclear and ambiguous contract, contracting and tendering disputes, inaccuracies in the estimation of materials, etc., (Singh, 2009; Moubaydeen et al., 2013; Bemelmans et al., 2012; Gibbs et al., 2017; Burke & Harris, 2016; Sarhan et al., 2017).

Assessment of 4P and Types of Delays

In addressing the synergy between the 4P and the types of delay from existing literature, it could be observed that each 'P' may have one or more type(s) of delay(s). For instance, project scope may be said to be associated with compensable delay if the changes in scope were caused by the client or his representative. If the changes in the project scope were caused by the contractor, supplier or subcontractor, then it could be said to be a non-excusable delay, however, the contractor is entitled to some form of compensation from the subcontractor or the supplier if the delay is caused by them. In a situation where the delay is caused by both the client, his representative and contractor, subcontractor or the supplier, it could be said to be a concurrent delay.

Again, project management could be related to compensable or non-excusable delay or concurrent where both delay types overlap. More also, in project participant source, when a delay is caused by client or his representatives such as consultant, client's design, and estimation team, it is a compensable delay. However, when it is caused by the

contractor, subcontractor or the supplier or in-house design and estimation team, it is a non-excusable delay. There may be a situation of concurrent delay as well.

Mostly, procurement delays are non-excusable as they are caused by the contractor and his supplier. Finally, there may be situations where adverse temperature, rain, flooding, a volcanic eruption, earthquake, external forces, among others, can cause changes in scope, procurement or project participant delays. This situation could be said to be the excusable or non-compensable type of delay.

Conclusion

In this paper, the 4P concept was validated through literature review for the identification, categorization, and analysis of delay sources in the internal construction project environment. First, the review indicated that the body of literature related delays assessment lacks cohesion and integrated focus, and the need to systematically assess, locate and develop comprehensive delay assessment framework within the internal project environment is not adequately addressed. To validate the concept, the study identified the sources of the delays and then further identified the individual risks associated with the sources. First, data from medium to large projects was gathered from peer-reviewed journals, conferences, books and other databases within the civil engineering, construction management, project management, technology management, architectural management, built environment, etc. To ensure the comprehensiveness of the concept, this study examined the references made by the authors to determine if those articles have relevant contributions or impacts. Finally, the study identified the sources of the delays and then further identified the individual risks associated with the sources. The risks or delay factors were then categorized under main sources based on shared characteristics.

The analysis showed that the main sources of delays in projects and their individual risks are associated with the 4P concept (Project Related, Practices, Participants and Procurement). The 4P concept undoubtedly presents a comprehensive tool for delay assessment. Explicitly, the study provides construction managements with an understanding of the main delay sources and their risks, and serve as a technique for project teams planning to evaluate their current project state, thus, determining the major risks and allocating reasonable resources and efforts for delay/risks management. Overall, the study makes a significant contribution to knowledge, delay identification and assessment, and if well understood, would be used for project performance assessment studies and contribute to the knowledge and practice of delay control in the project

environment. Although this study has explored the dynamics of the internal delay sources and their individual risks, further research into how the concept could be applied in specific project environments is required to better understand the concept and its implication for risks management. The authors are currently working on the exploration of the concept to different types of projects.

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References

Abd El-Razek, M.E., Bassioni, H.A. and Mobarak, A.M. (2008), "Causes of Delay in Building Construction Projects in Egypt", *Journal of Construction Engineering and Management*, Vol. 134 No. 11, pp. 831–841.

Abdelhamid, T.S. (2004), "The Self-Destruction and Renewal of Lean Construction Theory: A Prediction From Boyd's Theory", *Proceedings of the 12th Annual Conference of the International Group for Lean Construction, Helsingør, Denmark.*, IGLC, Helsingør, pp. 1–19.

Aftab, H.M. (2014), "Contractor perspective on time overrun factors in Malaysian construction projects", *International Journal of Science, Environment and Technology*, Vol. 3 No. 3, pp. 1184–1192.

Akinsola, A.O., Potts, K.F., Ndekugri, I. and Harris, F.C. (1997), "Identification and Evaluation of factors influencing variations on building projects", *International Journal of Project Management*, Vol. 15 No. 4, pp. 263–267.

Al-Aghbari, W. and Mohammed. (2005), *Factors Affecting Construction Speed of Industrialized Building Systems in Malaysia*, University Putra Malaysia, available at: http://psasir.upm.edu.my/6067/1/FK_2005_52%281-24%29.pdf (accessed 30 August 2016).

Al-Kharashi, A. and Skitmore, M. (2009), "Causes of delays in Saudi Arabian public sector construction projects", *Construction Management and Economics*, Vol. 27 No. 1, pp. 3–23.

Al-Momani, A.H. (2000), "Construction delay: a quantitative analysis", *International Journal of Project Management*, Vol. 18 No. 1, pp. 51–59.

Alaghbari, W., Razali A. Kadir, M., Salim, A. and Ernawati. (2007), "The significant factors causing delay of building construction projects in Malaysia", *Engineering, Construction and Architectural Management*, Emerald Group Publishing Limited, Vol. 14 No. 2, pp. 192–206.

Ansah, R.H. and Sorooshian, S. (2017), "Effect of lean tools to control external environment risks of construction projects", *Sustainable Cities and Society*, Vol. 32, pp. 348–356.

Ansah, R.H., Sorooshian, S., Mustafa, S. Bin and Duvvuru, G. (2016a), "Lean Construction Tools", *Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management Detroit, Michigan, USA, September 23-25*, IEOM Society International, Detroit, Michigan, USA, pp. 784–793.

Ansah, R.H., Sorooshian, S., Mustafa, S. Bin and Duvvuru, G. (2016b), "Assessment of Environmental Risks in Construction Projects: A Case of Malaysia", *Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management Detroit, Michigan, USA, September 23-25*, IEOM Society International, Detroit, Michigan, USA, pp. 752–763.

Ansah, R.H., Sorooshian, S., Mustafa, S. Bin and Duvvuru, G. (2016c), "Advancing Towards Delay-Free Construction Project: A Review", *Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management Detroit, Michigan, USA, September 23-25*, IEOM Society International, Detroit, Michigan, USA, pp. 744–751.

Ansah, R.H., Sorooshian, S. and Mustafa, S.B. (2015), "The 4Ps: A Framework for Evaluating Projects Delays", *Proceedings of Engineering Technology International Conference (ETIC 2015) 10-11 August 2015, Bali, Indonesia*, ETIC, Bali, Indonesia.

Ansah, R.H., Sorooshian, S., Shariman, B.M. and Oludapo, O.S. (2017), "Constructions project management risks' framework", *Quality - Access to Success*, Vol. 18 No. 158, pp. 90–95.

Arcuri, F.J., Hildreth, J.C. and Tech, V. (2007), *The Principles of Schedule Impact Analysis*, *Virginia Polytechnic Institute and State University*, Virginia, available at: www.vt.edu (accessed 26 August 2016).

Assaf, S.A. and Al-Hejji, S. (2006), "Causes of delay in large construction projects", *International Journal of Project Management*, Vol. 24 No. 4, pp. 349–357.

Aziz, R.F. (2013), "Ranking of delay factors in construction projects after Egyptian revolution", *Alexandria Engineering Journal*, Faculty of Engineering, Alexandria University, Vol. 52 No. 3, pp. 387–406.

Aziz, R.F. and Hafez, S.M. (2013), "Applying lean thinking in construction and performance improvement", *Alexandria Engineering Journal*, Faculty of Engineering, Alexandria University, Vol. 52 No. 4, pp. 679–695.

Bemelmans, J., Voordijk, H. and Vos, B. (2012), "Supplier□contractor collaboration in the construction industry", *Engineering, Construction and Architectural Management*, Emerald Group Publishing Limited, Vol. 19 No. 4, pp. 342–368.

Bing, L., Akintoye, a., Edwards, P.J. and Hardcastle, C. (2005), "The allocation of risk in PPP/PFI construction projects in the UK", *International Journal of Project Management*, Vol. 23, pp. 25–35.

Birgonul, M.T., Dikmen, I. and Bektas, S. (2015), "Integrated Approach to Overcome Shortcomings in Current Delay Analysis Practices", *Journal of Construction Engineering and Management*, Vol. 141 No. 4, p. 4014088.

Burke, C.M. and Harris, M.J. (2016), "Acceleration and Mitigation of Project Delays", *Construction Contract Claims, Changes, and Dispute Resolution, Third Edition*, American Society of Civil Engineers, Reston, VA, pp. 139–152.

Chan, D.W.M. and Kumaraswamy, M.M. (1997), "A comparative study of causes of time overruns in Hong Kong construction projects", *International Journal of Project Management*, Vol. 15 No. 1, pp. 55–63.

Chan, D.W.M. and Kumaraswamy, M.M. (2001), "Compressing construction durations: Lessons learned from Hong Kong building projects", *International Journal of Project Management*, Elsevier BV, Vol. 20 No. 1, pp. 23–35.

Channel News Asia. (2014), *Are Tightening Foreign Worker Quotas Causing Construction Delays?: MPs*, *Channel News Asia, Special Report*, available at: http://research.dwg.com.sg/home/2014/may-2014/30th-may-2014.

Chua, D.K.H., Kog, Y.C. and Loh, P.K. (1999), "Critical Success Factors for Different Project Objectives", *Journal of Construction Engineering Management*, Vol. 125, pp. 142–150.

Cooper, D.F., Grey, S., Raymond, G. and Walker, P. (2005), *Project Risk Management Guidelines: Managing Risk in Large Projects and Complex Procurements*, *John Wiley & Sons Ltd*, John Wiley & Sons Ltd, Chichester, United Kingdom.

Dissanayaka, S.M. and Kumaraswamy, M.M. (1999), "Evaluation of factors affecting

time and cost performance in Hong Kong building projects", *Engineering Construction and Architectural Management*, Vol. 6 No. 3, pp. 287–298.

Elbeltagi, E., Ammar, M., Sanad, H. and Kassab, M. (2016), "Overall multiobjective optimization of construction projects scheduling using particle swarm", *Engineering, Construction and Architectural Management*, Emerald Group Publishing Limited , Vol. 23 No. 3, pp. 265–282.

Faridi, A. and El-Sayegh, S. (2006), "Significant factors causing delay in the UAE construction industry", *Construction Management and Economics*, Vol. 24 No. 11, pp. 1167–1176.

Fertitta, T.D., Nedinsky, A.L. and Gilmore, J.G. (2016), "Construction Project Delays and Time Extensions", *Construction Contract Claims, Changes, and Dispute Resolution*, American Society of Civil Engineers, Reston, VA, pp. 117–137.

Frimpong, Y., Oluwoye, J. and Crawford, L. (2003), "Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study", *International Journal of Project Management*, Vol. 21 No. 5, pp. 321–326.

Gibbs, D.-J., Lord, W., Emmitt, S. and Ruikar, K. (2017), "Interactive Exhibit to Assist with Understanding Project Delays", *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, Vol. 9 No. 1, p. 4516008.

Glenn, E. (2007), "The Importance and Awesome Power of Project Management in Today's Business Environment", *Associates and The Renaissance Group*, evancarmichael.com, available at: http://www.evancarmichael.com/library/glenn-ebersole/The-Importance-and-Awesome-Power-of-Project-Management-in-Todays-Business-Environment.html.

González, V.A., Sacks, R., Pavez, I., Poshdar, M., Alon, L. Ben and Priven, V. (2015), "Interplay of Lean Thinking and Social Dynamics in Construction", *23rd Annual Conference of the International Group for Lean Construction*, pp. 681–690.

Haider, W. and Haider, A. (2012), "Managing Complexity in Technology Intensive Projects", *2012 Proceedings of PICMET '12: Technology Management for Emerging Technologies.*, IEEE, Vancouver, BC, Canada, pp. 2419–2426.

Haseeb, M., Xinhai-Lu, Bibi, A., Maloof-ud-Dyian and Rabbani, W. (2011), "Problems of Projects and Effects of Delays in the Construction Industry of Pakistan", *Australian Journal of Business and Management Research*, Vol. 1 No. 5, pp. 41–50.

Hass, K.B. (2010), "Introducing the New Project Complexity Model", *PM Times for*

Project Managers, ProjectTimes, Canada, available at: https://www.projecttimes.com/articles/introducing-the-new-project-complexity-model-part-i.html (accessed 15 August 2017).

Ho, P.H.K. (2016), "Labour and skill shortages in Hong Kong's construction industry", *Engineering, Construction and Architectural Management*, Emerald Group Publishing Limited , Vol. 23 No. 4, pp. 533–550.

Hwang, B.-G., Zhao, X. and Yu, G.S. (2016), "Risk identification and allocation in underground rail construction joint ventures: contractors' perspective", *Journal of Civil Engineering and Management*, Taylor & Francis, Vol. 22 No. 6, pp. 758–767.

Hwang, B., Shan, M. and Supa'at, N.N.B. (2017), "Green commercial building projects in Singapore: Critical risk factors and mitigation measures", *Sustainable Cities and Society*, Vol. 30, pp. 237–247.

Iyer, K.C. and Jha, K.N. (2006), "Critical Factors Affecting Schedule Performance: Evidence from Indian Construction Projects", *Journal of Construction Engineering and Management*, Vol. 132 No. 8, pp. 871–881.

Jiang, W. and Lu, Y. (2017), "Influence of initial trust on control from client perspective: construction industry in China", *Engineering, Construction and Architectural Management*, Vol. 24 No. 2, pp. 326–345.

Klemetti, A. (2006), "Risk Management in Construction Project Networks".

Lowsley, S. and Linnett, C. (2006), *About Time: Delay Analysis in Construction*, RICS.

Mamman, E.J. and Omozokpia, E.. (2014), "An Evaluation of Factors Affecting the Performance of Construction Projects in Niger State", *Journal of Environmental Sciences and Resource Management*, Vol. 6 No. 1, pp. 34–43.

Manley, K. and Chen, L. (2016), "The impact of client characteristics on the time and cost performance of collaborative infrastructure projects", *Engineering, Construction and Architectural Management*, Emerald Group Publishing Limited , Vol. 23 No. 4, pp. 511–532.

Mbachu, J. and Nkado, R. (2007), "Factors constraining successful building project implementation in South Africa", *Construction Management and Economics*, Taylor & Francis , Vol. 25 No. 1, pp. 39–54.

Megha, D. and Rajiv, B. (2013), "A Methodology for Ranking of Causes of Delay for Residential Construction Projects in Indian Context", *International Journal of Emerging Technology and Advanced Engineering*, Vol. 3 No. 3, pp. 396–404.

Memon, A.H., Rahman, I.A., Abdullah, M.R. and Abde, A.A.A. (2014), "Factors

affecting construction cost performance in project management projects: Case of MARA large projects", *International Journal of Civil Engineering and Built Environment*, Vol. 1 No. 1, pp. 30–35.

Memon, A.H., Rahman, I.A., Abdullah, M.R., Asmi, A. and Azis, A. (2011), "Assessing the Effects of Construction Delays on MARA Large Projects", *International Journal on Advanced Science, Engineering and Information Technology*, Vol. 1 No. 6, pp. 624–629.

Moubaydeen, S., Pope, J., Tuck, J., Walker, M. and Mackay, N. (2013), "Construction and projects in Qatar: overview", *Construction and Projects, Practical Law - Multi-Jurisdictional Guide 2013/14, Thomson Reuters*, Doha, Qater, pp. 1–11.

Mpofu, B., Ochieng, E.G., Moobela, C. and Pretorius, A. (2017), "Profiling causative factors leading to construction project delays in the United Arab Emirates", *Engineering, Construction and Architectural Management*, Vol. 24 No. 2, pp. 346–376.

Norzima, Z., Sorooshian, S. and Hou, K.C. (2011), *Effective Project Management: In Building Construction*, LAP Lambert Academic Publishing, available at: https://books.google.com.my/books/about/Effective_Project_Management.html?id=VHOypwAACAAJ&redir_esc=y.

Ogunlana, S.O., Promkuntong, K. and Jearkjirm, V. (1996), "Construction delays in a fast-growing economy: Comparing Thailand with other economies", *International Journal of Project Management*, Vol. 14 No. 1, pp. 37–45.

Othman, A. and Ismail, S. (2014), "Delay in Government Project Delivery in Kedah, Malaysia", *Recent Advances in Civil Engineering and Mechanics*, pp. 248–254.

Owalabi, J.D., Amusan, L.M., Oloke, C.O., Olusanya, O., Tunji-Olayeni, P., OwolabiDele, PeterJoy, et al. (2014), "Causes and effects of delay on project construction delivery time", *International Journal of Education and Research*, Vol. 2 No. 4, pp. 197–208.

Patel, A.M., Jayesh, K., Pitroda, R. and Bhavsar, J.J. (2013), "A Study of Risk Management Techniques for Construction Projects in Developing Countries", *International Journal of Innovative Technology and Exploring Engineering*, Vol. 3 No. 5, pp. 139–142.

PMI, A. (2004), "A Guide to the Project Management Body of Knowledge (PMBOK® Guide)-Third Edition", *PM Network*, Project Management Institute, Vol. 20 No. 3, p. 82.

Ramabodu, M.S. and Verster, J.J.P. (2010), "Factors Contributing to Cost Overruns of Construction Projects", *Proceeding of ASOCSA 5th Built Environment Conference, Durban South Africa*, pp. 131–143.

Salleh, R. (2009), *Critical Success Factors of Project Management for Brunei Construction Projects: Improving Project Performance.*, Queensland University of Technology, available at: http://eprints.qut.edu.au/38883/1/Rohaniyati_Salleh_Thesis.pdf (accessed 20 August 2016).

Salunkhe, A.A. and Patil, R.S. (2014), "Effect of Construction Delays on Project Time Overrun: Indian Scenario", *IJRET: International Journal of Research in Engineering and Technology*, Vol. 3 No. 1, pp. 2319–1163.

Sambasivan, M., Deepak, T.J., Salim, A.N. and Ponniah, V. (2017), "Analysis of delays in Tanzanian construction industry", *Engineering, Construction and Architectural Management*, Emerald Publishing Limited , Vol. 24 No. 2, pp. 308–325.

Sambasivan, M. and Soon, Y.W. (2007), "Causes and effects of delays in Malaysian construction industry", *International Journal of Project Management*, Vol. 25 No. 5, pp. 517–526.

Saqib, M., Farooqui, R.U. and Lodi, S.H. (2008), "Assessment of Critical Success Factors for Construction Projects in Pakistan", *First International Conference on Construction In Developing Countries (ICCIDC–I) "Advancing and Integrating Construction Education, Research & Practice"*, pp. 392–404.

Sarhan, S., Pasquire, C. and King, A. (2017), "The concept of Institutional Waste within the Construction industry: A potential theoretical framework", *Lean Construction Journal*, pp. 12–24.

Shehu, Z., Endut, I.R. and Akintoye, A. (2014), "Factors contributing to project time and hence cost overrun in the Malaysian construction industry", *Journal of Financial Management of Property and Construction*, Vol. 19, pp. 55–75.

Shehu, Z., Endut, I.R., Akintoye, A. and Holt, G.D. (2014), "Cost overrun in the Malaysian construction industry projects: A deeper insight", *International Journal of Project Management*, Elsevier Ltd, Vol. 32 No. 8, pp. 1471–1480.

Singh, R. (2009), "Delays and Cost Overruns in Infrastructure Projects -- An Enquiry into Extents, Causes and Remedies", *Working Papers*, Centre for Development Economics, Delhi School of Economics.

Sorooshian, S. (2014), "Delay-based reliability analysis on construction projects", *Life*

Science Journal, Vol. 11 No. Spec. Issue 3, pp. 104–113.

Sorooshian, S. (2015), "Modification of risk assessment value to test industry reliability", Vol. 1660, AIP Publishing, p. 90009.

Sorooshian, S., Norzima, Z., Yusof, I. and Rosnah, Y. (2010), "Effect Analysis on Strategy Implementation Drivers", *World Applied Sciences Journal*, Vol. 11 No. 10, pp. 1255–1261.

Spina, G., Caniato, F., Luzzini, D. and Ronchi, S. (2013), "Past, present and future trends of purchasing and supply management: An extensive literature review", *Industrial Marketing Management*, Vol. 42 No. 8, pp. 1202–1212.

Spina, G., Caniato, F., Luzzini, D. and Ronchi, S. (2016), "Assessing the use of External Grand Theories in Purchasing and Supply Management research", *Journal of Purchasing and Supply Management*, Vol. 22 No. 1, pp. 18–30.

Tumi, S.A.H., Omran, A. and Pakir, A.H.K. (2009), "Causes of Delay in Construction Industry in Libya", *The International Conference on Economics and Administration*, No. November, pp. 265–272.

Umair, M., Choudhary, M.A. and Jahanzaib, M. (2014), "A Review of Large - Scale Hydropower Project in Public Sector of Pakistan", *KICEM Journal of Construction Engineering and Project Management Online ISSN*, Vol. 4 No. 4, pp. 47–59.

van de Vijver, M.A.R. (2009), *Collaboration in Buyer-Supplier Relationships*, CentER, Tilburg University, available at: https://pure.uvt.nl/portal/files/1073769/DEC_1_2008_FINAL_VERSION_Thesis_Mark_van_de_Vijver.pdf (accessed 24 April 2017).

Walker, D.H.T. (1995), "An investigation into construction time performance", *Construction Management and Economics*.