energies

MDPI

Article

Causes of Delay in Power Transmission Projects: An Empirical Study

Goutom K. Pall, Adrian J. Bridge *, Jason Gray and Martin Skitmore

School of Civil Engineering and Built Environment, Queensland University of Technology (QUT), 2 George Street, Brisbane, QLD 4001, Australia; goutom.pall@hdr.qut.edu.au (G.K.P.); jm.gray@qut.edu.au (J.G.); rm.skitmore@qut.edu.au (M.S.)

* Correspondence: a.bridge@qut.edu.au; Tel.: +61-07-3138-1543

Received: 31 October 2019; Accepted: 2 December 2019; Published: 19 December 2019

check for updates

Abstract: Power transmission (PT) projects are vital for the power sector. However, worldwide PT projects experience delay. There is an urgent need to understand the unique causes of delays in PT projects. This paper presents the first empirical study on causes of delays in PT projects via a comprehensive literature review. Based on this literature review, 63 potential delay factors are identified and divided into ten major groups. These include two new groups of delay attributes, comprising sector-specific factors (SSF) and general factors (GF), where SSF pertains solely to PT projects and GF contributes to minimizing the bias of project participants. A questionnaire survey of 311 PT stakeholders is conducted to determine the overall ranking of the delay factors using the relative importance index. The results indicate that SSF, GF, and external/unavoidable factors are the most critical groups of delay factors, with the top-ranked factors being right of way problems of transmission line (TL), frequent changes in TL routes, and accessibility to the TL tower locations. Finally, recommendations are made to help minimize time overruns in PT projects, as well as in other linear power and non-power construction projects in general.

Keywords: power transmission projects; project delay; schedule delay; power projects

1. Introduction

Since the industrial revolution, power has been the mainstay of development of modern civilization. The demand for electric power in the modern world is increasing rapidly and is predicted to almost double by 2040 from 2014 [1]. Besides the traditional resources, the recent contributions from the renewable energy sources are significantly subsidized to the achievement of forecasted 40,000 TWh (terawatt hour) power generation in 2040 [1]. Studies show that power transmission (PT) and power distribution system losses are more than 15% of the generated electricity [2]. Hence, a reliable and functional PT network, an essential link between power generation and distribution, is required to transmit the forecasted generated power to the consumer because most of the power generators are stationed far from the developed regions [3]. In order to streamline the smooth transmission of the generated forecasted electricity to the distributors and/or customers, it is clear that the world will see a significant increase in PT projects in the near future. Most of the countries in the world are very keen to complete their power sector projects in time and, hence, timely completion of PT projects is crucial, because without a reliable PT link, power generation and distribution systems are effectively disabled. Moreover, development partners offer flexible soft financial support for the PT sector development, but the planned benefits are partially or never realized due to the frequent delay in PT projects completion [4]. Therefore, the timely completion of PT projects can significantly contribute to the betterment of human civilization by making electricity accessible whenever and wherever it is needed.

PT is at the heart of the power sector, and project management in the PT sector is challenging because of the presence of high-voltage PT lines and right of way (RoW) issues, which makes PT projects significantly different in scope from other linear power and non-power projects [5,6]. Also, PT project management is thought-provoking because they are usually sited in remote areas, away from existing establishments such as electricity and water supplies, and thus entails careful planning [7]. Despite the criticality of PT projects, the research on the PT projects' schedule management is embryonic and has not revealed all the key factors involved. More precisely, Pall et al.'s (2016) [5] comprehensive literature review revealed that PT projects have their own unique causes of delay beyond power generation, power distribution, and other non-power linear construction projects, and recommended an empirical investigation into the causes of delay and relationships between them. In response to Pall et al.'s (2016) [5] recommendation, an updated review of the latest literature still shows that there is no empirical study on the causes of delay in PT projects. Hence, this paper presents an empirical study that takes the first step to identify the potential causes of PT project delays worldwide, including their relative impact and interdependencies.

The objectives of this study are to:

1. Identify and classify the potential causes, or factors, of delays to PT projects;
2. Rank the importance of the factors according to the various parties involved and explore the extent of their agreement;
3. Establish the relationships between the delay factors; and
4. Make recommendations for minimizing delays based on the outcomes of the study.

In the next section, the authors revisit and update the review by Pall et al. concerning the factors that contribute towards delay in PT projects. In so doing, the grouping of the factors is checked and updated. This is followed by details concerning the research method, in which the study setting and context is given, along with details of the preparation of the research instrument for sampling. The results and discussion follow, including ranking and correlation of the delay factors are given and discussed in terms of their importance in PT projects, including corresponding theoretical and practical contributions. The authors conclude by evaluating the overall contributions of the study, acknowledging its limitations, and suggesting future research.

2. Literature Review

Electric power is the keystone of the modern era. As a significant resource, it affects all countries' economies and political and social security [8]. The power sector consists of three subsectors: power generation, power transmission, and power distribution. The PT sector is an essential part of the electric power system, and it is the critical area of focus for keeping pace with worldwide development. PT system augmentation is inevitable because of the ever-growing electricity demand and challenges in developing new electricity sources. Public opposition and lack of community acceptance are major issues in PT projects management [9,10]. PT projects characteristically cross many different owners land and, hence, new transmission line (TL) construction is usually contrasting by local people and landlords [11]. It is noticed that the main causes of delays in construction of new TL/TLs are authorisation processes, project stakeholders agreement, and public and political support [12]. Powerlines crossing environmentally and culturally sensitive areas frequently cause delays in PT project implementation [6]. PT projects face social, political, environmental, management, and technical risks [13–15]. Moreover, in a complicated restructured electricity market, the planning processes of new TLs usually take an extended time [7,12].

In spite of PT projects' significance, there are no detailed empirical studies that investigate the delay factors of PT projects. Therefore, PT project management literature vis-a-vis delays is sparingly available and, hence, a review of the possible causes is undertaken based on the projects most closely related to PT projects, consisting of non-power linear projects, trailed by power generation projects, and finally power distribution projects. The literature was reviewed using the broad set of search criteria from wide sources with eight disciplines (comprising policies related to energy, utility-related policies, management in engineering, project and construction management, architecture, environment, and advance research) linked with all foremost bibliographic databases such as Web of Science, Scopus, Science Direct, Google Scholar, Social Science Research, ProQuest Research Library, Library Articles Search, Literature Resource Center, Academic Search Complete, and Journal Storage (JSTOR) [5]. The review aimed to reveal all the reported causes of delays in PT and other power sector projects. A total of 86 published articles were reviewed and organized into three main levels based on how specific or close the literature in each level was to PT projects. That is, from most close to least closely related, the causes of delay in power distribution, power generation, and non-power linear projects, as shown in Figure 1. Aside from the apparent causes, the root causes of underperformance concern the systematic underestimation of the complexities and scope changes of the project during development and decision-making [16]. However, this study focuses on the more readily observable and conventional causes of delay in PT. In so doing, a part of the literature related to the root causes of underperformance is excluded in this study.

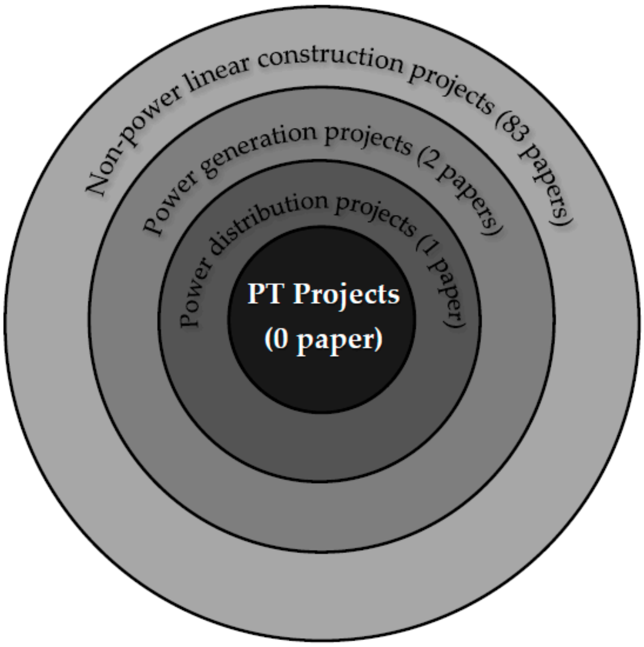


Figure 1. Literature reviewed related to power transmission (PT) projects.

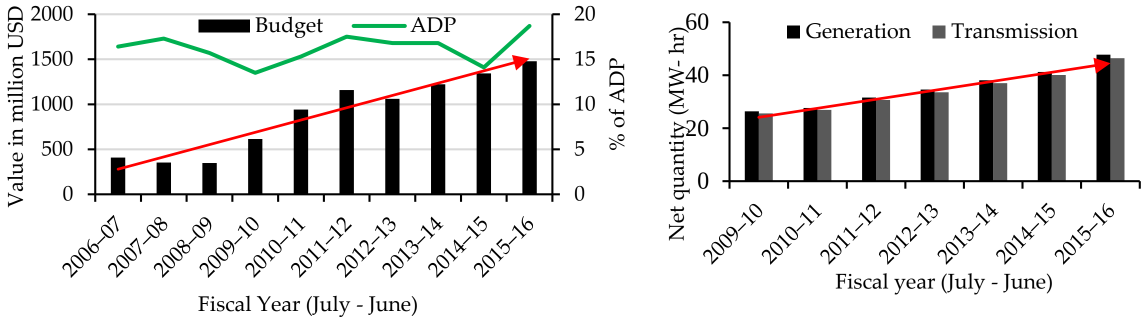
Since a significant time is spent during the construction phase of a PT project, it is realistic to expect that most delays occur in this stage. It is logical, therefore, to study the causes of delays in construction projects, and most specifically non-power linear projects, as foundational in finding causes of PT project delays [5]. The applicability of the factors causes delays in power generation vis-à-vis PT projects increases further than linear construction projects, as these projects consist of the construction of stations and substations that also exist in PT projects [5]. Power distribution projects have not only the stations/substations, but also the powerlines and, hence, PT projects are closer to power distribution projects than power generation projects [5]. Of the total of 86 published studies related to causes of delay, 83 papers are related to nonpower linear construction projects, power generation projects provide two papers [17,18], and power distribution projects provide one paper [19]. The non-power linear projects include: construction of buildings (20 papers) [20–39], petrochemical construction (one paper) [40], construction of oil and gas lines (two papers) [41,42], railway construction (one paper) [43], highway/road related construction (eight articles) [44–51], and other construction projects (51 papers) [52–102]. Based on the above studies and a content analysis of the factors related to delay revealed from the literature review, as shown in Appendix A, this study recommends nine groups to include all delay attributes of a project. That is administrative/corporate-related issues, employer/owner-related issues, contractor-related issues, consultant-related issues, drawing-related issues, materials-related issues, equipment-related issues, labour/worker-related issues, and external/miscellaneous issues. The summarised delay factors from Appendix A are presented in Appendix B under the above mentioned groups, including some modifications based on experts' recommendations during a preliminary survey.

The literature review indicates that late procurement of special construction equipment, unavailability of its spare parts, and its late delivery at site cause significant delay in power generation projects, which is not pertinent to general non-power linear construction projects [5]. Hence, these outcomes indicate that the causes of delay of non-power projects do not account for all those factors related to power generation projects, some of which are related only to power generation projects and possibly PT projects. In addition, power distribution line construction gets delayed due to the interference with other construction projects, such as road/highway construction, building construction, and PT line construction. However, low-voltage power distribution lines generally cross various administrative borders and hence face more regulatory and public/political issues. It is clear, therefore, that the factors causing delay in power generation and non-power linear projects do not include all those factors associated with power distribution projects, some of which are applicable only to power distribution and possibly PT projects [5]. It is investigated that PT projects are likely to have their own unique causes of delay beyond non-power construction, power generation, and power distribution projects, and hence need urgent empirical investigation [5].

3. Research Methods

3.1. Study Setting

Bangladesh has much in common with the rest of world in terms of its power requirements, including the expansion of its industries, agricultural work, workforce, healthcare, and significant development in communications, resulting in an ever-increasing demand for power [103]. Realizing the importance of the faster expansion of power systems for future social and economic development, the government of Bangladesh (GoB) aims to more than double the country's 2010 power generation by 2021 according to its Power Sector Master Plan (PSMP) [104]. The GoB has increasingly funded the power sector, with power projects allocated more than 15% of the annual development program (ADP), as shown in Figure 2a [105]. In the 2015–16 financial year, the contribution of power was 1.45% of Gross Domestic Product (GDP) [106]. In support of this, the PSMP also recommends the expansion and development of PT infrastructure to cope with the enhanced power generation [104]. The GoB's initiatives are also supported by the development partner Asian Development Bank (ADB), and ADB states that the rapid economic growth in Bangladesh at 6% a year during 2005–2010 is causing electricity demand to increase exponentially. As such, the GoB is trying to reduce the gap between generation and demand [107,108]. In addition to GoB funding, total private sector investment, from 2014 to 2030, is projected to be around USD 22.3 billion, which is almost half the GoB funding [109]. In order to obtain the best use of these funds, Bangladesh is exploring the electricity sources within and across its borders. For example, Bangladesh already imported electricity from India and there are also ongoing processes to purchase electricity from other neighboring countries (i.e., Myanmar, China and other south Asian countries) [110,111]. The GoB has also announced the necessity for around USD 20 billion investment to expand associated PT projects [109]. Furthermore, Bangladesh has started to procure a nuclear power plant [112], and the GoB has also targeted solar energy to be 10% of total generation [113]. These initiatives have resulted in a significant increase in power generation capacity from 4942 megawatts (MW) in 2009 to 12,780 MW in 2016, and in this period, per capita generation of power also increased from 220 kilowatt-hours (kWh) to 380 kWh [106]. According to the GoB master plan, power generation will increase to 24,000 MW in 2021 and 40,000 MW in 2030 [106]. To keep pace, the relevant authority in Bangladesh—a public limited company solely responsible for the development, operation, and maintenance of the national grid—has committed to construct around 10,513 circuit kilometers of TLs and 160 substations (SSs) at different voltage levels during 2016–2021 [114].



(**a**)Allocated budget with ADP for power sector (**b**)Trend of PT projects implementation

Figure 2. PT projects in Bangladesh.

This trend in PT system development, in conjunction with the increase in power generation, is also evident from Figure 2b, and indicates a proportional development in PT projects with power generation [114]. Hence, there will be a noteworthy surge in the number of PT projects in the near future to ensure the timely transmission of the generated electricity. Despite the criticality of upcoming PT projects, approximately 80% of these foreign-aided development projects are currently delayed in Bangladesh, resulting in financial losses and hindering planned development [115]. As such, Bangladesh provides a fertile context upon which to conduct this first-ever empirical study into the causes of PT project delay.

3.2. Data Collection

Beyond the nine groups of delay causes mentioned in the updated literature review section, PT projects comprise a number of causes unique to PT projects and not found in power generation, power distribution, or other non-power linear projects [5]. Hence, as a part of the first objective in this study, we develop the groupings presented by Pall et al. (2016) [5] to account for PT sector-specific factors before proceeding to address objectives 2 and 3, which concern testing the relevancy and adequacy of the delay factors.

To do this, a two-stage questionnaire was used to collect data for this study. A preliminary questionnaire was developed for the first stage, containing five sections (respondent's general information, case project details, factors contributing to the case project delay, the group effect on the case project delay, and further comments). Section 1 of the questionnaire elicited such demographic information as experience with PT project work, professional background, and most recent affiliation type (owner/contractor/consultancy). Section 2 detailed the specification of a specific case project (i.e., "the case project") most familiar to the respondent, which was either most delayed or least delayed in last five years, about which the answers from the respondent are based. Additionally, the respondents answered questions concerning the type and scope of the project, contractual and actual project duration, voltage level of TLs and SSs, again, all in relation to the case project. Section 3 asked how much each factor contributed to the delay of the selected case project. This response was based on a five-point Likert scale from 1 (very minor contribution) to 5 (very major contribution), with additional 'no effect' and 'don't know' options [116]. Section 4 evaluated the most critical individual group of factors contributing towards the case project delay, while Section 5 requested "further comments" in the form of other factors not mentioned in the questionnaire (i.e., not revealed from the literature review) that potentially contributed to the delay of the participant's case project. In this first stage, expert contacts were collected online (www.pgcb.org.bd) and by personal communications. Participants were selected randomly from each category and the questionnaire sent by email and/or online survey portal. Ten questionnaires were sent to both the employers and contractors and five to the consultants. In total, 18 completed responses were returned, comprising seven owners, eight contractors, and three consultants. The responses from the owners comprised three project directors having minimum 15 years' experience, and two executive engineers, one executive technical director, and one manager from the project finance division having a minimum of 12 years' experience. Five senior international and three national contractor personnel responded, each having worked over 20 years as a PT project manager. Two international and one national consultant also responded, with 15 years or more experience in PT projects. Furthermore, 11 Bangladeshi, two Indian, one German, one Spanish, one Korean, and two Chinese experts participated in the preliminary survey.

As a result of the experts' strong recommendations, a new and unique group of delay factors was introduced into the final questionnaire: namely, 'sector-specific factors (SSF)'. The SSF group contains the causes of delays that are applicable to PT projects and are listed as Group 1 in Appendix B. The sector experts' opinions also suggested a new group of factors to minimize respondents' bias. This was based on the extraction of factors common to the project owner, contractor, and consultants, due to their collective responsibility for such matters as drawing related issues where, in a turnkey contract environment, owners are responsible for the approval, contractors are usually accountable for designing, drafting, and submission, and consultants provide comments and recommendations on the submitted drawings. This resulted in a second new group of 'general factors (GF)' and the deletion of group 5: Drawing related issues of the literature reviewed by Pall et al. (2016) [5].

The final questionnaire was developed in the second stage based on the comments and feedback from the 18 PT sector experts surveyed in the first stage. This was essentially the same as the preliminary questionnaire, but with the PT-specific and project parties' (i.e., owners, contractors, and consultants) general factors redistributed to the GF groups as summarized and coded in Appendix B. Group 9: External/miscellaneous was renamed as 'Group 10: External/unavoidable factors'.

3.3. Data Analysis

The data were collected via both online and hard copy questionnaires in accordance with the ethical requirements for research involving humans developed by Australia's National Health and Medical Research Council [117]. This data was analyzed using SPSS 25 and MS Excel for ranking the factors overall and by the three groups of project parties (employer, contractor, and consultant) using a relative importance index.

The diverse profile of respondents and projects greatly assists in establishing the relative importance of the various factors responsible for PT project delay. The means and standard deviations are not appropriate measures for evaluating the overall relative importance (ranking) of the delay factors, as they do not consider the relationships involved [83]. Instead, the Relative Importance Index (RII) is often used to rank the causes of delays [29], with

$$RII = \sum_{i=1}^{5} \frac{a_i \times x_i}{N}$$

where i denotes the response category index, a_i denotes the weight of the response for category i, x_i is the frequency of the response for category i, and N is the total number of respondents. The values of RII, therefore, range from 1 to 5, with the higher RII value indicating a higher rank.

Cronbach's alpha ($C\alpha$) is used to test the internal reliability consistency. This is a popular and powerful method to estimate the reliability of a construct/group for a confirmatory factor approach to summarize the information contained in the group [118]. The $C\alpha$ reliability test is also used to judge the appropriateness of the delay factors in a group and the $C\alpha$ values range from 0 to 1, with a value close to 1 indicating greater internal reliability [63]. Doloi (2009) suggests a frequently used rule of thumb of $C\alpha > 0.90$ as excellent, $0.90 > C\alpha > 0.80$ as good, $0.80 > C\alpha > 0.70$ as acceptable, $0.70 > C\alpha > 0.60$ as questionable, $0.60 < C\alpha > 0.50$ as poor, and $C\alpha < 0.50$ as unacceptable [119].

Spearman's rank order correlation (SROC) coefficient is used to test the significance of the correlation between the factors in each group and examine the degree of agreement between the project parties. SROC is a distribution-free or nonparametric test and thus does not assume homogeneity of variance and is not influenced by outliers as it compares medians [59]. SROC coefficients (rho) range from +1 to −1, where close to +1 indicates a strong positive relationship/agreement, close to −1 means a strong negative relationship/agreement, and close to 0 means a weak or no relationship/agreement. This study uses the following formula to calculate the SORC [59]:

$$\rho_s = 1 - \frac{6 \sum d^2}{n^3 - n}$$

where ρ_s is the Spearman rank correlation coefficient between two project parties, d is the difference in rank between two variables for a single delay cause, and n is the number of rank pairs.

4. Results and Discussion

4.1. Response and Respondents' Profile

A wide range of respondents was targeted to obtain a representative sample of the population [74]. Therefore, data were collected from all levels of PT project professionals (national or international) who are still working and/or have worked in Bangladesh. Table 1 contains a summary of the respondents' profiles, which indicates a good mix in terms of the experience and expertise of the project parties.

Table 1. Respondents' profile.

Project Parties	Experience in Years					Total	Professional Role	Participants by Designation			
	<5	5–10	10–15	15–20	>20			EE	20.58%	Consultants	2.57%
Employer	8	103	33	16	33	193	62.06%	PM	18.33%	CE	1.29%
Contractor	3	43	33	10	21	110	35.37%	SAE	16.08%	GM	0.96%
Consultant	1	0	4	0	3	8	2.57%	SE/PD	16.72%	CM	4.18%
Total	12	146	70	26	57	311		PE	9.65%	AE	2.89%
Experience%	3.86	46.95	22.51	8.36	18.33			SDE	6.11%	Others	0.64%

Note: SDE = Sub-divisional engineer, CE = Chief engineer, GM = General Manager, CM = Construction manager, and AE = Assistant engineer.

The list of the participants was prepared by using employee lists from related organizations websites (www.pgcb.org.bd; www.bpdb.gov.bd). Introductory conversations and online contacts were made with the respondents to explain and clarify the objectives of the study and content of the questionnaire. A total of 532 experts were approached and 339 responses were obtained, constituting a 63.72% response rate. Of these, 28 responses were considered incomplete because of missing data, especially in the extensive choice of 'no effect' and 'don't know'. The remaining 311 responses were used in the analysis that follows. Data collection was based on a broad spectrum of PT project management personnel, comprising employers, national and international contractors, and consultants. The majority of the respondents (72.30%) are Bangladeshi, working nationally and internationally in PT projects, followed by 10.50% Indian, 4.90% Chinese, 4.5% German, 4.2% Spanish, and 3.60% Korean respondents.

As shown in Table 1, the majority of respondents are owners and contractors, with a very small number of consultants. Approximately 50% have more than 10 years' experience in PT project management. In terms of profession, over 33% are executive engineers (EE) working as owners' project managers or contractors' project managers (PM), with a further 25% being owners' sub-assistant Engineers (SAE) and contractors' project engineers (PE) mainly working on site. The other major group of respondents comprises owners' superintending engineers (SE) working as project directors and contractors' project directors (PD), and all of whom have considerable knowledge of PT project implementation. The results are therefore informed by a very deep knowledge of PT projects delay in Bangladesh. Moreover, samples show that more than 60% of the projects have been delayed for more than six months.

4.2. Ranking and Correlation of the Delay Factors

Appendix C provides the delay factors ranked by the RII and arranged according to their groups, as provided in Appendix A. Individual delay factors and delay groups are ranked based on individual and the overall project parties' view. The critical individual and group delay factor rankings are also presented in Table 2, as shown below.

Table 2. Critical delay factors and groups.

Critical Individual Delay Factors								Critical Delay Groups							
Overall		Owners		Contractors		Consultants		Overall		Owners		Contractors		Consultants	
Causes	Rank	Causes	Rank	Causes	Rank	Causes	Rank	Groups	Rank	Groups	Rank	Groups	Rank	Groups	Rank
SSF1	1	SSF1	1	SSF1	1	SSF1	1	SSF	1	SSF	1	SSF	1	SSF	1
SSF3	2	SSF3	2	GF4	2	SSF3	2	GF	2	GF	2	GF	2	E_UF	2
SSF5	3	E_UF9	3	SSF3	3	SSF2	3	E_UF	3	E_UF	3	E_UF	3	E_ORF	3
GF1	4	GF9	4	GF9	4	E_UF9	4	E_ORF	4	E_ORF	4	E_ORF	4	GF	4
GF4	5	CRF2	5	GF1	5	E_ORF4	5	MRF	5	CRF	5	AF	5	AF	5
GF9	6	SSF5	6	E_ORF4	6	GF1	6	CRF	6	MRF	6	MRF	6	CRF	6
E_UF9	7	GF4	7	E_UF9	7	GF4	7	AF	7	AF	7	ERF	7	ERF	7
E_ORF4	8	GF1	8	GF8	8	GF9	8	ERF	8	ERF	8	CRF	8	MRF	8
GF5	9	E_ORF4	9	SSF5	9	SSF5	9	ConRF	9	ConRF	9	ConRF	9	L_WRF	9
E_UF1	10	E_UF1	10	GF5	10	CRF2	10	L_WRF	10	L_WRF	10	L_WRF	10	ConRF	10

The overall Cα value of the factors is 0.927 and the Cα values of the groups are greater than 0.8, indicating a good level of internal reliability consistency. The SROC correlations between the factors under each group are shown in Appendix D and are described later in this section along with the ranking of the delay factors.

4.3. Factors Contributing to PT Project Delay

Typically, PT projects across the world consist of SS and high voltage TL that carry power from distant power sources to demand centers [120]. The essential consideration of the TL voltage (electrical induction) makes the PT projects significantly different from any other projects. TL can be hundreds of kilometers long, which makes it difficult to obtain a RoW without any problems. As with RoW, the voltage level and electrical induction properties of the TL make the route changing remarkably different from other projects. Furthermore, the overhead TL (OHTL) construction requires special technical considerations when crossing existing TLs and other infrastructures, such as railways, roadways, and telephone lines, which can result in significant time overruns. TL construction usually starts from the middle of the route and approaches towards the substations at both ends. With any significant change in the substation's gantry or dead-end tower positions, the TL route needs to shift from its planned direction, which demands the drawings are changed and technical considerations, which, in turn, prolong the delay. Moreover, the construction timing of dead-end towers of the TL or hook-up gantries of substations can adversely affect project completion and is unique to PT projects. The TL is usually routed through open fields away from localities and infrastructures, but does require sophisticated equipment for its construction, erection, and stringing; these issues (especially erection and stringing) are significantly different from any other projects. The river crossing tower construction of the TL is not usually found in any other construction projects. TL tower erection and stringing, including the remote discrete tower foundation construction, render the logistic support of the supervision team critical. Generally, supervision of the construction, erection, and stringing of the tower foundations on hills or in water necessarily demands a wide range of logistic support to deliver the works smoothly. In addition, the remote SS location, electrical properties of the sophisticated equipment involved, and the big/heavy transformer installation at the SS, make considerations of the access road construction of SS and the transportation of the equipment to the SS different from other projects.

Project delay is defined as the additional time involved in completing a project beyond its contractual duration. A delay is a situation in which a contractor, consultant, or client/owner jointly or independently contribute to the delay of a project's completion time [121]. The five major causes of delay in PT project management considered by each project party are presented in Table 3, which reflects the uniqueness of PT project management. The groups and associated delay factors are discussed below in the light of the existing studies and the expert opinions collected during the preliminary survey under Section 5 of the preliminary questionnaire.

Table 3. Major delay causes indicated by the project parties.

Causes of Delay	Ranked as/by			
	Overall	Owner	Contractor	Consultant
Right of Way (RoW) problems of TL (SSF1)	1	1	1	1
Frequent TL route changes (SFF3)	2	2	3	2
Accessibility to the TL tower locations (SSF5)	3	6	9	9
Poor communication and coordination among the project parties (GF1)	4	8	5	6
Delay in payments (GF4)	5	7	2	7
Political interventions (strikes, etc.) (E_UF9)	7	3	7	4
Drawing and/or design related problems (GF9)	6	4	4	8
Insufficient experience of the contractor's technical staff (CRF2)	12	5	22	10
Delay in construction of dead end towers of TL/gantries of substation (SSF2)	25	24	24	3
Approval processes of project documents (E_ORF4)	8	9	6	5

4.3.1. Sector-Specific Factors (SSF)

As Table 3 shows, the 'right of way (RoW) problems of the transmission line' or SSF1 (RII = 3.585) is ranked as the most critical factor contributing to PT project delay in both the individual and combined view of the project parties. This is because RoW problems are very unpredictable and common in PT projects, and also known to all the project parties. The RoW is a strip of land along the TL having the same width on both sides of the TL centerline [5]. The minimum RoW width is approximately 20 m for the overhead TL (OHTL) and increases with the increase in TL voltage level, and RoW not applicable for underground TL [122]. RoW problems have many unknown dimensions, from regulatory issues to changes in land demographics. Regulatory acts prohibit TLs from crossing existing structures, i.e., educational institutions, religious establishments, graveyards, forests, market places, and households [123]. The RoW may have to be altered because of a sudden change in river courses, unpredictable ground conditions (i.e., sand boiling), and sudden flooding along the TL routes. There is also no compensation for the RoW in most countries, which is one of the critical issues prolonging delays, as many landowners try to hinder TL construction as it often leaves their land unusable for future development. Moreover, due to the lack of any incentives, landowners sometimes intentionally build settlements in the RoW just before the TL construction starts on site, which can substantially affect the completion time because of the lengthy legal procedures involved which can be found in linear road construction projects [44,45].

Second overall in the SSF group, and quite close to RoW, is 'frequent TL route changes' (SSF3) at RII = 3.495. This ranking is agreed by the project parties except for the contractors, who rank it third.

Mainly contractors approach route changes and owners with recommendations from consultants to approve or reject the route after due audits. Route changes can occur primarily due to RoW problems, followed by the erroneous route surveys, public resistance, and other unavoidable circumstances. The type of contract also affects route changes, as contractors prefer to take the shortest route to increase their profit margin and hence are inclined to keep changing routes.

Ranked third overall in the SSF group at RII = 3.371 is 'accessibility to the TL tower locations' (SSF5), with the owners ranking this higher than the other two project parties. Transporting construction and other materials to the tower location presents a major challenge that can become extreme when the TL runs across water bodies and hilly areas. Sudden floods or heavy rains can also interfere with access to the tower locations and delay the project. The location of the TL dead-end tower depends on the hook-up gantry position of SS, and SS and TL contracts are generally awarded to different contractors. If the SS contractor changes the SS layout significantly because of difficulties or errors, it creates massive dismantling work (foundations and towers) for the TL contractors and can prolong project completion time for years. Hence, SSF2 is a critical issue ranked third (RII = 3.500) by the consultants, while the ranking of the other parties is less critical.

Overall, the SSF attributes group is the most critical and hence ranked as first, both individually and collectively, see Table 2. The factors in the SSF group have good reliability ($C\alpha$ = 0.905) and are significantly correlated, as shown in Appendix D.

4.3.2. General Factors (GF)

'Poor communication and coordination between the project parties' (GF1) is very apparent across all kinds of projects [41]. Consistent with Sambasivan and Soon and other studies, Table 3 indicates that GF1 is also a major delay factor [69,74]. Collectively GF1 (RII = 3.363) is evaluated as the 4th most critical overall, with the owners, contractors, and consultants individually assigning it 8th, 5th, and 6th place, respectively. Poor communications compromise the effective coordination of project stakeholders, which leads to increased rework and hence delay. This generally occurs due to the insufficient flow of information. Of all the stakeholders involved, project managers are the key point of contact, and hence their negotiation skills significantly affect coordination and thus project progress.

'Delay in payments' (GF4), at RII = 3.357, is the 5th most critical factor as shown in Table 3, indicating the importance of the funding capabilities and payment procedures of all the project parties because of being a chain between the two main project parties. In alignment with existing literature, this also emphasizes the liquidity of the project stakeholders and the need to pay special attention to smooth disbursements to reduce delay [24]. It is often not the funding, but the lengthy bureaucratic procedures that delay the owner's payments and thus impede physical progress by making it difficult for the contractor to achieve planned progress. Hence, while the contractors rank GF4 the 2nd most critical, it is ranked 7th by the owners and consultants.

Corresponding with existing findings, 'Drawing and/or design related problems' (GF9), ranked 6th overall at RII = 3.354, is also of major importance as shown in Table 3. In a turnkey contract environment, consultants play a vital role in drawing design-related issues, and their skills determine the quality of their work [35]. Unclear owner specifications and erroneous contractor designs complicate the situation and hamper expected progress [80]. As final victims, contractors and owners both rank this (GF9) as 4th out of their top five factors, while the consultants, being less affected, rate it 8th. Moreover, 'Improper site management and supervision' (GF5) and 'poor planning and scheduling' (GF6) of the GF group are ranked as 9th and 11th respectively. With four factors in the top 10, this indicates the criticality of GF. Hence the overall (RII = 3.328), owners (RII = 3.295), and contractors (RII = 3.464) ranking of GF is 2nd out of 10 groups, as shown in Table 2. The $C\alpha$ value of the GF group is 0.882, and significant correlations exist between the factors as shown in Appendix D.

4.3.3. Administrative Factors (AF)

The 'approval processes of government agencies' (AF2) is the critical delay factor in the AF group with an overall 15th rank (RII = 3.045) and with contractors ranking it as 14th (RII = 3.155) as listed in Appendix C, which aligns with the findings of Doloi and others [52,84]. Owners and consultants rank AF2 as 16th and 29th, respectively, because the owner's project execution division wants to disburse payment quickly, but fail due to the lengthy certification process from the owner's other related departments and consultants are usually financially solvent, with less liabilities to pay contractors. The internal consistency reliability of AF is significant (Cα = 0.868) and Appendix D exhibits significant correlations between the delay factors.

4.3.4. Employer/Owner-Related Factors (E_ORF)

This group is collectively ranked as 4th of the 10 groups as shown in Table 2. Owners and contractors both also rank E_ORF as 4th, while consultants rank it 3rd. 'Approval processes of project documents' (E_ORF4) is the most critical factor in this group and jointly ranked 8th (RII = 3.251). Prompt approval of project documents is important for the progress of the project but can be a lengthy organizational process that can become even lengthier when less experienced professionals are involved [73]. E_ORF4 is also rated 9th (RII = 3.202), 6th (RII = 3.391), and 5th (RII = 3.250) by the owners, contractors, and consultants, respectively. E_ORF has significant Cα value (0.801) and the factors in this group have strong correlations as shown in Appendix D.

'Owner-demand change orders (E_ORF1)' of this group is significantly different from the 'changes in the scope of works (E_ORF5)' because E_ORF1 changes initiated by the employers and the E_ORF5 arise because of unavoidable technical issues occurring during implementation and the urgency associated with solving the problems by all the project parties. Moreover, any delays in the payment of the customs duty and value-added tax for importing equipment (E_ORF2) is the sole responsibility of the employer and beyond the usual contract prices between the project parties.

4.3.5. Contractor-Related Factors (CRF)

The contractor is of the utmost importance for completing any project on time. 'Inadequate experience of contractors' (CRF2) is the most critical factor in this group, with the owners and consultants ranking it 5th and 10th respectively as shown in Appendix C. CRF2 is mainly attributed to the contract awarding process because the lowest bidder is awarded the project irrespective of its experience [36]. While Cα = 0.902 indicates good reliability of the group, Appendix D indicates significant correlations between the factors.

4.3.6. Consultant-Related Factors (ConRF)

The ConRF group does not directly contribute to delay because consultants only coordinate with owners for the smooth execution and are less accountable for timely completion. In a design-built turnkey (DBT) contract environment, as already stated, consultants are not liable for the approval process, but rather provide comments, recommendations, and technical assistance to the owner. From this group, 'Late comments on design and/or contract scope' (ConRF1) is collectively ranked as 31st—a ranking also supported by the owners and contractors, whereas consultants ranked it as least critical (54th) as shown in Appendix C. However, the factors in ConRF group are the most reliable (Cα = 0.925) and strongly correlated as listed in Appendix D.

4.3.7. Materials-Related Factors (MRF)

The contractor is mainly responsible for this group in a turnkey contract environment and the overall ranking is 5th, while the owners and consultants rank it 6th and 8th respectively as shown in Table 2. The overall critical items from this group is 'construction materials shortage on-site' (MRF1) followed by 'delay in materials delivery to site (MRF2)', with corresponding overall rankings of 23rd and 27th as shown in Appendix C. The consultants disagree with the overall observation, indicating that MRF2 is more critical than MRF1, due to the shipment of materials from overseas [36]. The reliability ($C\alpha$ = 0.827) and correlations between the factors in the group MRF are statistically significant as shown in Appendix D.

4.3.8. Equipment-Related Factors (ERF)

Unexpectedly, the contractors rank this group more critical than others, as they are mainly responsible for the supply of equipment for DBT projects [124]. Overall, the most critical item in this group is the 'lack of modern equipment' (ERF4) followed by the 'shortage of civil and mechanical equipment' (ERF1). Foreign turnkey contractors usually subcontract the construction work to local civil contractors who cannot afford modern sophisticated equipment. The reliability of the factors in ERF is 0.803, and the correlations are significant for this group, as shown in Appendix D.

4.3.9. Labor/Worker-Related Factors (L_WRF)

Being ranked 10th, this group is the least critical of all 10 groups, although the consultants rank it as 9th as shown in Table 2. 'Availability of skilled labor' (L_WRF2) is critical but no other factors in this group are significant because of the readily available labor in Bangladesh. Statistically, the group factors are reliable ($C\alpha$ = 0.809) and they have good correlations, as seen in Appendix D.

4.3.10. External/Unavoidable Factors (E_UF)

This group is one of the most critical. The overall (RII = 3.186), owners (RII = 3.171), and contractors (RII = 3.191) rank this group as 3rd, but the consultants (RII = 3.500) rank E_UF as 2nd, more critical than other project parties, as provided in Table 2. The most critical factor in this group is 'political interventions' (E_UF9) in the form of strikes and blockades. Bangladesh suffers transport interruptions frequently due to strikes, which adversely affects the storage of construction materials on-site arriving from distant sources, and the delivery of the equipment from ports to site prolongs delays [125]. Considering the unavoidable nature of E_UF9, the owners (RII = 3.482) and consultants (RII = 3.375) rank this as 3rd and 4th, respectively, while the contractors and overall ranking of E_UF9 is 7th. The overall (RII = 3.235) and owners' (RII = 3.197) ranking for 'heavy rain or floods' (E_UF1) is 10th [59] and also the other parties agree with the severity of this item, ranking it 11th and 13th by the consultants and contractors, respectively. According to all the parties, E_UF1 is followed by 'local public resistance' (E_UF8) and 'unforeseeable ground conditions' (E_UF5), respectively. This group has significant internal reliability ($C\alpha$ = 0.817) and the correlations between the factors in this group are substantial, as seen in Appendix D.

4.4. Agreement between the Project Parties

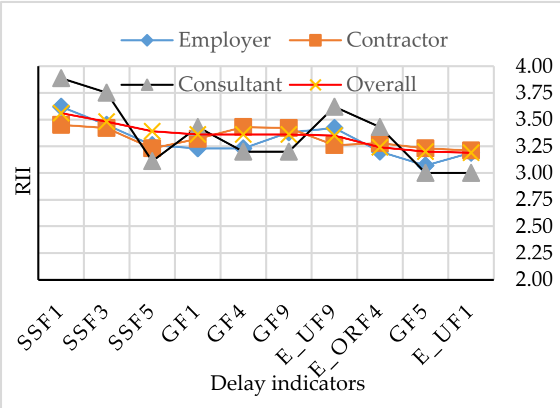
This study uses Spearman's correlation coefficient to summarize the strength and direction (negative or positive) of agreement between two project parties. It is evident from the analysis that owners and contractors have the strongest agreement (0.929^{**}) in ranking the delay causes, followed by the agreement between owners and consultants (0.776^{**}) and between contractors and consultants (0.726^{**}), as shown in Table 4. Moreover, the agreement between the project parties is significant at the 0.01 level.

Table 4. Agreement between project parties.

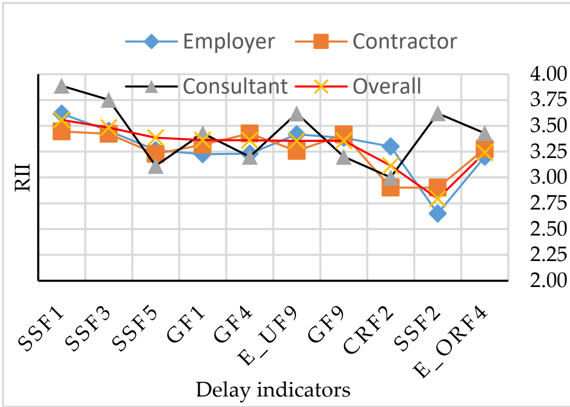
Project Parties Agreement			
	Owner	Contractor	Consultant
Owner	1		
Contractor	0.929 **	1	
Consultant	0.776 **	0.726 **	1

** = Correlation is significant at the 0.01 level (two-tailed).

As described earlier, this study introduced a new group, GF, that contains factors involving the responsibilities of all the project parties to obtain less biased responses. The GF group significantly reduces the factors from the project parties labelled groups (E_ORF, CRF and ConRF), resulting in an extremely strong agreement between the project parties that is also evident from Figure 3.



(**a**) Overall top 10 delay factors



(**b**) Top five critical delay factors

Figure 3. Agreement between project parties in ranking the delay factors

Figure 3a shows the strong agreement between the project parties in ranking the overall top 10 delay factors as summarized in Table 2. Noticeably, overall, employers and contractors are close in ranking the top 10 delay factors in PT projects. Moreover, the most critical five factors both overall and in view of the individual project parties from Table 3 are presented in Figure 3b, and support a close agreement in ranking the critical factors. While both overall and other project parties almost coincide, the consultants rank a few factors differently. Figure 3 underpins the claim of a less biased sample due to the introduction of the GF group.

4.5. Theoretical Contribution

Revisiting the updated literature review based on the study of Pall et al. (2016) [5], Figure 4 illustrates how this study contributes to advancing not just our understanding of delays in PT projects, but also our understanding of delays to power distribution, power generation, and non-power linear construction projects worldwide. With regard to PT projects, the study provides the first evidence of a unique group of delay factors SSF. More broadly, the study also develops the first approach to addressing bias between stakeholders—by creating the General Factors (GF) group comprising factors to which stakeholders share delivery responsibility.

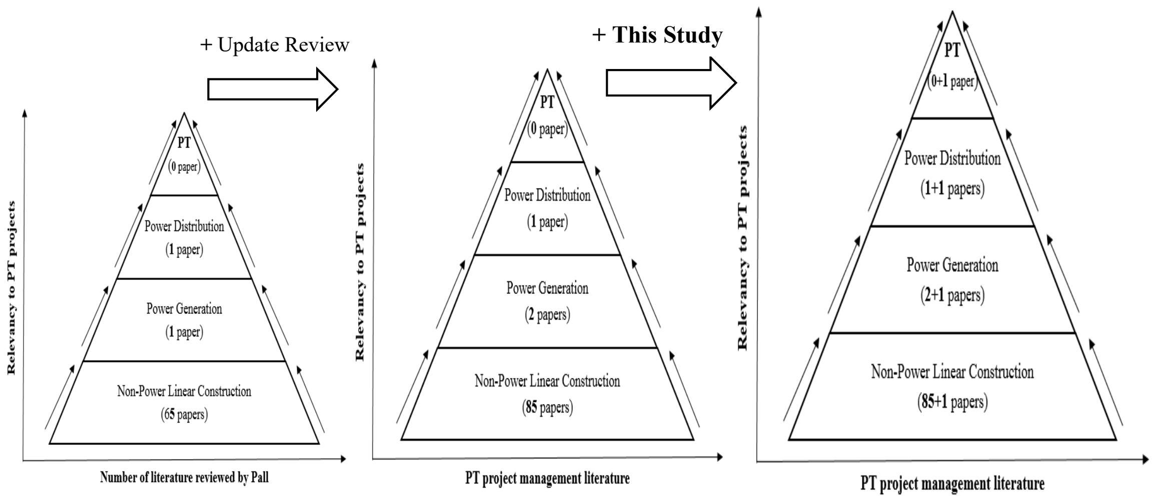


Figure 4. Theoretical contribution (Reproduced by permission of the Institution of Engineering & Technology [5]).

4.6. Practical Contribution

Delays are common for all types of projects, including power transmission (PT) projects, and these are widely recognized as a costly, complex, and risky problem [12]. Since delays are costly to all project parties, including extended timelines that threaten development, their minimization is important for all concerned. However, delays can be minimized when their causes are identified [126]. Building on the outcomes of this study, it is suggested that the project parties, including PT and other linear power and non-power project personnel, can significantly reduce delays by adopting the measures below: Owners to pay special attention to:

- Finalizing the TL routes, paying special attention to legal issues and demographic information of the RoW in terms of community consultation, floods and soil properties;
- funding the projects smoothly, with minimum official procedures and speedy approval of the project documents to maintain the seamless progress of site works;
- establishing an effective communication protocol between the project parties, engaging an efficient project manager to identify priority areas to keep pace with the updated planned schedule;
- ensuring the engagement of technically sound and experienced contractors and consultants, considering their resources and capabilities in line with the project's scope;
- exploring and maintaining an effective framework, obtaining the timely approval of the drawings and design; and
- focusing on the activities and holding coordination meetings between TL and SS contractors, minimizing the risks of TL route changes.

Contractors to consider:

- Better understanding their legal and contractual obligations, involving finalizing a route with minimum RoW problems and least TL route changes;
- establishing an efficient communication and coordination framework, ensuring timely interactions between the subcontractors, owners, and other project stakeholders;
- ensuring the continuous flow of funds, reducing the dependency on payments from the owners;
- engaging a dedicated and scope-wise team of experts, dealing with drawing design-related issues and timely monitoring progress;
- updating the planning and scheduling of the project's progress, ensuring resource availability and taking into account natural calamities and political interventions; and

- appointing locally experienced and technically sound staff, especially the project manager, providing quick solutions to problems that arise during the project life cycle.

Consultants to consider:

- Finalize the route, visiting the site physically, and considering the country-specific laws for the selection and compensation related to RoW;
- engage a dedicated team with capabilities and expertise suited to a specific project; and
- review the submitted design-drawings as soon as possible, discussing any issues to expedite approval.

5. Conclusions

The overall results provide strong evidence that the sector-specific factors (SSF) comprise the most critical group causing significant delays in PT projects, followed by general factors (GF) and external/unavoidable factors (E_UF). Collectively, the most critical factors are RoW problems, frequent changes in TL routes, accessibility of the tower locations, poor communication and coordination among the project parties, and payment delays. Furthermore, there is a strong agreement between the project parties, indicating that all the stakeholders are acutely aware of the critical factors involved.

The study provides insights into the causes of time overruns encountered in the implementation of PT projects. Most specifically, the findings allow professionals to develop more realistic project schedules and to include measures to mitigate delays and the corresponding financial losses associated with delays. For project management practitioners, the research also provides insights into the causes of delay in power distribution, power generation and non-power linear projects and provides a substantial foothold for advance study of the causes of PT project delay worldwide. Furthermore, since PT is an essential part of an electric power system, a key contribution of this paper is its potential for the advancement of future human civilization.

The study's limitations relate to the extent to which the analysis can speak to the subtle and nuanced ways the factors interrelate. Hence, further analysis using such techniques as structural equation modeling (SEM) and discrete choice analysis (DCA) are likely to yield a further understanding of the relationships between the factors involved. That said, and given the size and importance of the PT sector worldwide, the study provides desperately needed evidence and advice to significantly advance value for money in the delivery of power projects and, in turn, contribute to global economic growth.

Author Contributions: G.K.P. designed the research, collected the data and analyzed the data. A.J.B., J.G. and M.S. supervised the study. All authors equally wrote the manuscript. All authors read and approved the final manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors gratefully acknowledge comments made by the reviewers and the Editor.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Potential Causes of Delay in the Reviewed Literature.

No.	Reference	Major Causes of Delay
		Building Projects
1	Alaghbari, W.e., et al. [32]	Financial difficulties and economic problems, slowness in making decisions, slow to give instructions, unavailability of materials, poor site management
2	Kumaraswamy, M.M. and D.W.M. Chan [33]	Delays in design, delay in drawings approval, poor site management and supervision, unrealistic contract durations imposed by client, mistakes and discrepancies in design documents
3	Abd El-Razek, M.E., H.A. Bassioni, and A.M. Mobarak [34]	Financing by contractor during construction, delays in contractor's payment by owner, design changes by owner or his agent during construction, partial payments during construction, and non-utilization of professional construction/contractual management
4	Le-Hoai, L., Y. Lee, and J. Lee [35]	Poor site management and supervision, poor project management assistance, financial difficulties of owner, financial difficulties of contractor, design changes
5	Odeh, A.M. and H.T. Battaineh [36]	Owner interface, inadequate contractor experience, financing and payments, slow decision making, improper planning, subcontractor selection
6	Chan, D.W.M. and M.M. Kumaraswamy [37]	Poor site management and supervision, unforeseen ground conditions, low speed of decision making involving all project teams, client-initiated variations, necessary variations of works
7	Kaming, P.F., et al. [38]	Unpredictable weather conditions, inaccuracy of materials estimate, inaccurate prediction of craftsmen production rate, inaccurate prediction of equipment production rate, material shortage
8	Agyakwah-Baah, A.B. and F.D.K. Fugar [39]	Delay in honoring payment certificates, underestimation of cost of projects, underestimation of complexity of projects, difficulty in accessing bank credit, poor supervision
9	Al-Momani, A.H. [20]	designers, user changes, weather, site conditions, late deliveries, economic conditions, increase in quantity
10	Durdyev, S., M. Omarov, and S. Ismail [21]	Deficiency of materials on site, too short project duration, late delivery of material, lack of skilled labor, complexity of project, labor absenteeism delayed progress payments by the owner, poor site management, delay by subcontractor, accidents at site
11	Sweis, G., et al. [22]	Financial difficulties faced by the contractor, too many change orders by the owner
12	Koushki, P.A., K. Al-Rashid, and N. Kartam [23]	Changing orders, owners' financial constraints, owners' lack of experience in the construction business
13	Hamzah, N., et al. [24]	Financial difficulties and economic problems, financial problems, supervision too late and slowness in making decision, slow to give instructions, lack of materials on market, poor site management, materials shortages on site, construction mistakes and defective work, delay in delivery of materials to site, slowness in making decisions
14	Asiedu, R.O. and H.W. Alfen [25]	Recurrent default of interim payment by government, government's refusal to pay local for interest on delayed payments, lengthy payment processes resulting in delays, difficulty in arranging for extra funds when projects exceed their initial budget and interference, bribery and conflict of interest in the selection of contractors
15	Assaf, S.A., M. Al-Khalil, and M. Al-Hazmi [26]	Preparation and approval of shop drawings, delays in contractors' progress payment by owners, design changes by owners, cash problems during construction, relationships between different subcontractors' schedules in the execution of the project, slowness of the owners' decision-making process, design errors, excessive bureaucracy in project owner organization, labor shortages, inadequate labor skills
16	Aibinu, A.A. and H.A. Odeyinka [27]	Contractors' financial difficulties, architects' incomplete drawing, slow mobilization, equipment shortage
17	Ogunlana, S.O., K. Promkuntong, and V. Jearkjirm [28]	Materials procurement, waiting for information, laborers/tradesmen shortages, poor contractor management, design delays
18	Amoatey, C.T., et al. [29]	Delay in payment to contractor/supplier, inflation/price fluctuation, price increases in materials, inadequate funds from sponsors/clients, variation orders, and poor financial/capital market
19	Alwi, S. and K.D. Hampson [30]	Variable design changes, lack of trades' skill, slow in making decisions

Table A1. *Cont.*

No.	Reference	Major Causes of Delay
20	Islam, M.S., et al. [31]	Lack of experienced construction manager, lowest bidder selection, funding shortage by owner, lack of proper management, improper planning and scheduling, lack of skilled workers, site constraints, contractors' cash flow problems during construction, escalation of resources price, contractors' excessive workload
		Petrochemical Projects
1	Hong Pham, L. and H. Hadikusumo [40]	Poor communication and coordination by contractor with other parties, lack of quality control, unclear contract schedule
		Oil and Gas Projects
1	Fallahnejad, M.H. [42]	Imported materials, unrealistic project duration, client-related materials, land expropriation, change orders, contractor selection methods, payment to contractor, obtaining permits, suppliers and contractor's cash flow
2	Ruqaishi, M. and H.A. Bashir [41]	Poor site management and supervision by contractors, problems with subcontractors, inadequate planning and scheduling of projects by contractors, poor management of contractors' schedules, delay in delivery of materials, lack of effective communication among project stakeholders, poor interaction with vendors in the engineering and procurement stages
		Railway Projects
1	Seung, H.H., et al. [43]	They are lack of owner's abilities and strategies to manage high-tech oriented mega project, frequent changes of routes, inappropriate project delivery system, lack of proper scheduling tool tailored for a linear mega project, redesign and change orders
		Highway/Road Projects
1	Amoatey, C.T. and A. Alfred Nii Okanta [44]	Delay in finance and payment of completed work by owner, inadequate contractor experience, changes in scope by the owner during construction, delay to furnish and deliver the site to the contractor, inflexible funding allocation for project items
2	Soeng, S. and D.S. Santoso [45]	Working during rainy season, awarding the project to the lowest bidder, impact on people's land along the road construction project, poor site arrangement, management and supervision, frequent equipment breakdowns, long distance to borrow pits, poor ground condition and terrain, low productivity of labor, inadequate modern equipment, late progress payments
3	Aziz, R.F. and A.A. Abdel-Hakam [46]	Weather conditions, shortage (availability) in construction materials, slowness of the owner decision making process, poor site management and supervision by contractor, shortage of labor, accidents/mistakes during construction, slow delivery of materials, construction methods, shortage in equipment/insufficient numbers, financing by contractor during construction
4	Bruland, A., N. Dmaidi, and I. Mahamid [48]	Political situation, segmentation of the west bank and limited movement between areas, award project to the lowest bid price, progress payment delay by owner, shortage of equipment
5	Kaliba, C., M. Muya, and K. Mumba [49]	Delayed payments, financial processes and difficulties on the part of contractors and clients, contract modification, economic problems, materials procurement, changes in drawings, staffing problems, equipment unavailability, poor supervision, construction mistakes, poor coordination on site, changes in specifications, labor disputes and strikes
6	Mansfield, N.R., O.O. Ugwu, and T. Doran [50]	Finance and payment arrangements, poor contract management, materials shortages, inaccurate estimating, overall price fluctuations
7	Meeampol, S. and S.O. Ogunlan [51]	Construction method, management of construction resources, schedule management, supervision and control, communication
8	Aditya, A.K., D.A. Douglass, and M. Bhattacharya [47]	Decision making, difficulties in execution, failure of the contractor to perform
		Other Projects
1	Sambasivan, M., et al. [95]	Delay in progress payments, defective planning, delay in delivery of materials, unforeseen site condition, poor site management by contractors, consultant's late approval of tests and inspection, lack of communication between the project parties, delays in drawings approval
2	Mpofu, B., et al. [96]	Unrealistic contract duration imposed by client, incomplete design at the time of tender, too many scope changes and change orders, inadequate planning and scheduling, poor project planning and control
3	Kumar, S. [97]	Testing & qualification facility, raw material availability, design changes, hidden activities, lack of expertise, unexpected incidents, conflicts

Table A1. *Cont.*

No.	Reference	Major Causes of Delay
4	Jalal, M.P. and S. Shoar [98]	Labors rework, rework by consultant workforce, operation suspension, delay in progress payments, ineffective planning and scheduling of project, low productivity level of labors, change orders in documents, error in execution
5	Georgy, M., M. Kadry, and H. Osman [99]	Delays in site possession, change orders, unexpected adverse weather conditions, unavailable or limited mobilization area, poor planning, lack of adequate project coordination, issues clearing customs, delay in material fabrication, obstruction to owner-controlled site access, theft
6	Famiyeh, S., et al. [100]	Financial problems, unrealistic contract durations imposed by clients, poorly defined project scope, client-initiated variations, underestimation of project cost by consultants, poor inspection/supervision of projects by consultants, underestimation of project complexity by contractors, poor site management, inappropriate construction methods used by contractors, delays in the issuance of permits by government agencies
7	Oluwole, A. [101]	Design and documentation issues, effectiveness of financial management approaches, project management and contract administration approaches, efficiency in human resource, efficiency of materials and plant resources, contractor's site management style, information and communication technology tools, external factors
8	Agyekum-Mensah, G. and A.D. Knight [102]	Inadequate planning, finance and payment, slow in approving, variation, ground condition, labor supply and subcontractors, design changes, material shortage, manufactured and imported items, site management, weather, fluctuation, construction mistake, contractors experience, contingency or unforeseen
9	Adam, A., et al. [85]	Lack of communication between contractors and clients, inefficient communication, delayed payment to contractors/consultants, poor financial planning, price increases
10	Samarghandi, H., et al. [86]	Lack of attention to inflation and inefficient budgeting schedule, inaccurate budgeting and resource planning, weak cash flow and inaccurate pricing and bidding, inaccurate first draft and inaccuracies in technical documents, shortage of materials, price fluctuations
11	Abu Hassan, M.H.A. [87]	Low productivity of labor, delay in decision making, changes to the project by owner, delays related to subcontractors' work, unqualified workforce
12	Rao, B.P., et al. [88]	Delay in making the payments, lack of communication between parties, late issue of instruction, poor management and execution, delay in approving design document,
13	Arantes, A., P.F. da Silva, and L.M.D.F. Ferreira [89]	Slow decision making, changes in work scopes, unrealistic scheduling, poor contract specifications, contractor's financial inability and inappropriate bidding and contract award process
14	Bagaya, O. and J. Song [90]	Financial capability of the contractor, financial difficulties of the owner, equipment availability of the contractor, slow payments for completed work, poor sub-contractor performance by the contractor
15	Manzur, A., N. Ganesan, and M. Vinay [91]	Complexity in structural design of project, revisions to drawing during construction stage, slow site clearance, frequent rains, inadequate equipment, unqualified/unskilled laborers, quarry strike
16	Lindhard, S.M., et al. [92]	Unsettled or lack of project funding, delayed or long process times by other authorities, unsettled or lack of project planning, errors or omissions in construction work, lack of identification of needs
17	Kim, S.-Y., K.N. Tuan, and V.T. Luu [93]	Financial difficulties to owner, lack of supervisor's responsibilities, change design by owner, incompetence contractor, inadequate contractor experience, delay in subcontractors' work, change function of hospital from owner, lack of consultant's experience, incompetence owner, obsolete equipment
18	Oyegoke, A.S. and N.A. Kiyumi [94]	Selection of the lowest bid, instead of best bid for the client, financial condition of the main contractor, delay in decision-making by the client, poor construction planning by the main contractor
19	Shahhossein, V., M.R. Afshar, and O. Amiri [75]	Lack of timely financial allocation, payment delays to the contractor, changes and/or additional works
20	Angelidi, A. [76]	Change in orders by client during construction, slow decision making by client, insufficient and unclear information and details in design documents, lack of knowledge and experience of design team, poor coordination/communication between owner and design engineer during design phase
21	Lo, T.Y., I.W. Fung, and K.C. Tung [77]	Inadequate resources due to contractor/lack of capital, unforeseen ground conditions, exceptionally low bids, inexperienced contractor, works in conflict with existing utilities, poor site management & supervision by consultant

Table A1. *Cont.*

No.	Reference	Major Causes of Delay
22	Yang, J.B., C.C. Yang, and C.K. Kao [78]	Lack of determination of entitled government, lack of incentive for private investment, no qualified bidder, improper contract planning, uncompleted client-finished items, fluctuation on resource price, construction schedule delay, unclear definition of compensable and non-compensable project items
23	Ahsan, K. and I. Gunawan [79]	Lengthy procedure for contract evaluation and award, procurement delay, civil works and land acquisition delay, consultant recruitment delay, natural calamities, government procedural delay, local politics and economic problem, loan approval and disbursement delay, project staff hiring delay, new scope addition, frequent change of project staff (manager, director)
24	Marzouk, M.M. and T.I. El-Rasas [80]	Delay in progress payments by owner, variation orders by owner during construction, effects of subsurface conditions, unskilled labors, defective planning and scheduling of project, contractor's financial inability, project bidding and award types (negotiation, lowest bidder), shortage of construction materials, late approval of design documents by owner, less productive workforce
25	Aziz, R.F. [81]	Delay in progress payments (funding problems), different tactics patterns for bribes, shortage of equipment, ineffective project planning and scheduling, poor site management and supervision, poor financial control on site, rework due to errors, selecting inappropriate contractors, sudden failures actions, inadequate planning
26	Joseph, I.T.B., K.M. Augustine, and A.K. Theophilus [82]	Time constraints, financial issues/changes in micro economic indicators, delayed payment problems, availability of resources, poor project management structures, lack of technologically based systems
27	Doloi, H., A. Sawhney, and K.C. Iyer [83]	Delay in approval process, design and scope changes, change of subcontractors in the project, improper planning, inability of contractors to effective planning and controlling
28	Doloi, H., et al. [84]	Lack of commitment, inefficient site management, poor site coordination, improper planning, lack of clarity in project scope, lack of communication, substandard contract
29	K Pai, S. [65]	Too short contract duration, delay in progress payments, ineffective planning and scheduling of project by contractor, late in reviewing and approving design documents by consultant, mistakes and discrepancies in design documents, delay in material delivery, equipment breakdowns, shortage of labor, effects of subsurface conditions (e.g., soil, high water table)
30	Morris, S. [66]	Poor project planning and management skills, inadequate technical skills, poorly done ground surveys in the case of mining projects, delays in construction and equipment supply by other public enterprises
31	Venkatesh, M.P., S.M. Renuka, and C. Umarani [67]	Shortage of laborers, delivery of materials, shortage in construction materials, extra works (change orders and reworks), preparation of scheduling networks and revisions, skill of laborers, procurement of materials, materials selection and changes in types and specifications, maintenance of equipment, adverse weather effect on construction activities
32	Khoshgoftar, M., A.H.A. Bakar, and O. Osman [68]	Finance and payments of completed work, improper planning, site management, contract management, lack of communication between the parties
33	Bekr, G.A. [69]	Security measures, government change of regulations and bureaucracy, official and nonofficial holidays, low performance of lowest bidder contractors in the government tendering system, design and changes by owner, design changes by consultants, delay in progress payments by the owner, problems with local community, owner's lack of experience in construction
34	Mezher, T.M. and W. Tawil [70]	Financing and the scheduling of subcontractors, contractual relationships, design changes by owners, project management, rated shop drawings
35	Mohd, T.N., et al. [71]	Mistakes during construction, unrealistic project durations
36	Ramanathan, C.T. and S.P. Narayanan [72]	Rain effect on construction activities, shortage of laborers, poor site management and supervision by contractor, slowness in decision making by owners, poor and coordination communication by contractor with other parties, change orders by owners construction, late in revising and approving documents by owner, inadequate contractor's workers, unforeseen site conditions, delay in material delivery
37	Riazi, M., S. Riazi, and F. A Lamari [73]	Shortage of equipment, labor and important material, inconsistent project brief, policy changes due to changing political masters, lack of expert in government organization, incompetent consultant, contractor and government team, government and local authority bureaucracy, delay in handing over site to contractor
38	Sambasivan, M. and Y.W. Soon [74]	Contractor's improper planning, contractor's poor site management, inadequate contractor experience, inadequate client's finance and payments for completed work, problems with subcontractors, shortage in material, labor supply, equipment availability and failure, lack of communication between parties, mistakes during the construction stage

Table A1. *Cont.*

No.	Reference	Major Causes of Delay
39	Babatunde, S.O., O. Adeniyi, and O.A. Awodele [55]	Resettlement issues with political interference, non-availability of land with a higher cost of land transactions, weak planning institutions, rehabilitation issues with extensive legal delays
40	Skitmore, M. and A. Al-Kharashi [56]	Inexperienced contractor's technical staff, contractor's poor site management and supervision, suspension of work by the owner, delayed approval of major changes in the scope of work by consultant, shortage of construction materials, shortage of manpower
41	Enshassi, A., J. Al-Najjar, and M. Kumaraswamy [57]	Strikes and border closures, lack of materials in markets, delays in materials delivery to the site
42	Mohammed, K.A. and A.D. Isah [58]	Improper planning, lack of communication, design errors, shortage of supply
43	Assaf, S.A. and S. Al-Hejji [59]	Shortage of labor, unqualified workforce, inadequate contractor's experience, difficulties in financing project by contractor, low productivity level of labor, rework due to errors during construction, delay in progress payments by owner, original contract duration is too short
44	Mahamid, I., A. Al-Ghonamy, and M. Aichouni [60]	Bid award for lowest price, changes in material types and specifications during construction, contract management, duration of contract period, fluctuation of prices of materials, frequent changes in design, improper planning, inflationary pressure, lack of adequate manpower, long period between design and time of implementation, payments delay, poor labor productivity and rework
45	Yang, J.B. and S.F. Ou [61]	Unforeseen site conditions, inadequate contractor skill, low-quality delay by poor materials
46	Toor, S.U.R. and S. Ogunlana [62]	Lack of resources, poor contractor management, shortage of labor, design delays, planning and scheduling deficiencies, changed orders, contractors' financial difficulties
47	Ulubeyli, S., N. Tuncbilekli, and A. Kazaz [63]	Design and material changes, delay of payments, cash flow problems, contractor's financial problems, poor labor productivity, estimation problems, lack of feasibility studies, construction defects, unbalanced number of workers, fluctuation in material prices
48	Faridi, A.S. and S.M. El-Sayegh [64]	preparation and approval of drawings, shortage of manpower, poor supervision and poor site management, productivity of manpower, skill of manpower, non-availability of materials on time, obtaining permit/approval from the municipality/different government authorities, financing by contractor during construction, inadequate early planning of the project, slowness of the owner's decision-making process
49	Alinaitwe, H., R. Apolot, and D. Tindiwensi [52]	Changes to the scope of work, delayed payments, poor monitoring and control, the high cost of capital, political insecurity and instability
50	Aigbavboa, C.O., W.D. Thwala, and M.J. Mukuka [53]	Delay in progress payments, difficulties in financing projects by the contractor, delay in approving major changes in the scope of work
51	Yang, J.-B. and P.-R. Wei [54]	Changes in client's requirement, complicated administration process of client, insufficient or ill-integrated basic project data, unrealistic design duration imposed, slow land expropriation due to resistance from occupants
		Power Generation Projects
1	Batool, A. and F. Abbas [17]	Lack of political will, delay in civil work, delayed release of government funds, poor law and order situation, improper site investigation, poor management of project schedule
2	Pillai, N.V. and K.P. Kannan [127]	Improper technical project report, delay due to inter-state aspects, delayed authorization by central/state authorities, foreign currency exchange rates, land acquisition and rehabilitation, scope of work changes, changes in key personnel responsible for the advance planning and execution, erection specialists unavailability, construction materials shortage in market, spare parts of construction equipment, procurement delay of equipment, equipment delivery delay due to supplier's schedule failure and delay in delivering equipment at site
		Power Distribution Projects
1	Yau, N.-j. and J.-b. Yang [19]	Improper technical project report, Delay in land acquisition and rehabilitation, defective review process of government agencies, over-subjective clarification of rules by government officer, unfinished land usage changes, inappropriate review on related regulations, errors in estimate, delay due to long for architectural permissions, other construction projects delay and political intervention

Appendix B

Table A2. Delay Factors with their Groups and Coding.

Groups and Delay Factors	Coded as
Group 1: Sector-Specific Factors	SSF
Right of way (RoW) problems of transmission lines (TL)	SSF1
Delay in the construction of dead-end towers of TL/gantries of substation (SS)	SSF2
Frequent TL route changes	SSF3
Access road construction of SS	SSF4
Accessibility to the TL tower location (materials and/or equipment)	SSF5
Insufficient logistic support to monitor the TL works (transport)	SSF6
Difficulties in river crossing tower construction of TL	SSF7
Difficulties in transportation of equipment to the site for SS	SSF8
Group 2: General Factors	GF
Poor communication and coordination between the project parties	GF1
Change in the key personnel during planning and execution	GF2
Conflicts between contract clauses	GF3
Delay in payments	GF4
Improper site management and supervision (lack of local experience)	GF5
Poor planning and scheduling	GF6
Work distribution to team members (right people in the right place)	GF7
Poor coordination between various types of work	GF8
Drawing and/or design related problems	GF9
Ineffective delay penalties	GF10
Lack of incentives to finish earlier	GF11
Suspension of works	GF12
Group 3: Administrative Factors	AF
Tendering process	AF1
Approval processes of government agencies	AF2
Investigation during feasibility study	AF3
Inappropriate type of contract (Lump sum, Turnkey, BOOT)	AF4
Joint-ownership with other utility companies	AF5
Group 4: Employer/Owner Related Factors	E_ORF
Owner-demand change orders	E_ORF1
Late Custom Duty and Value-Added Tax payment to import equipment	E_ORF2
Late site handover to contractor (e.g., land acquisition and rehabilitation delays)	E_ORF3
Approval processes of project documents	E_ORF4
Changes in the scope of works	E_ORF5
Site utility connections (i.e., water, electricity, telephone)	E_ORF6
Changes in materials specifications during construction	E_ORF7
Group 5: Contractor Related Factors	CRF
Late site mobilization	CRF1
Insufficient experience of the contractor's technical staff	CRF2
Rework due to errors	CRF3
Poor construction methods	CRF4
Omissions or errors in estimate	CRF5
Group 6: Consultant Related Factors	ConRF
Late comments (contract scope and/or design documents)	ConRF1
Poor experience of consultant	ConRF2
Poor negotiation skills of consultants	ConRF3
Late inspection and testing by consultant	ConRF4
Misunderstanding of consultant with owner	ConRF5
Late arrival of erection consultant	ConRF6

Table A2. *Cont.*

Groups and Delay Factors	Coded as
Group 7: Materials Related Factors	MRF
Shortage of construction materials on site	MRF1
Late materials delivery on site	MRF2
Difficulties in obtaining special building materials	MRF3
Shortage of construction materials in the local market	MRF4
Group 8: Equipment Related Factors	ERF
Shortage of equipment (civil and/or electrical)	ERF1
Shortage of equipment spare parts	ERF2
Equipment breakdowns	ERF3
Lack of high-technology/efficient mechanical equipment	ERF4
Group 9: Labour/Worker Related Factors	L_WRF
Shortage of unskilled labour	L_WRF1
Shortage of skilled labour	L_WRF2
Personal conflicts between labourers	L_WRF3
Group 10: External/Unavoidable Factors	E_UF
Rain or floods	E_UF1
Extreme hot weather	E_UF2
Rules and regulation changes	E_UF3
Foreign exchange rate variations	E_UF4
Unforeseeable site conditions (e.g., existing underground conduits)	E_UF5
Unpredictable subsurface conditions (e.g., bad soil, high water table)	E_UF6
Accidents during construction	E_UF7
Local public resistance	E_UF8
Political interventions (strikes, blockades)	E_UF9

Appendix C

Table A3. Individual and Group Ranking of the Delay Factors.

Groups	Delay Factors	Individual Delay Factors Ranking								Delay Groups Ranking							
		Employer		Contractor		Consultant		Overall		Employer		Contractor		Consultant		Overall	
		RII	R	RII	R	RII	R	RII	R	RII	R	RII	R	RII	R	RII	R
SSF	SSF1	3.694	1	3.545	1	3.750	1	3.585	1	3.632	1	3.627	1	3.875	1	3.637	1
	SSF2	2.762	24	2.782	24	3.500	3	2.794	25								
	SSF3	3.497	2	3.455	3	3.625	2	3.495	2								
	SSF4	1.554	56	2.436	33	1.247	60	1.855	52								
	SSF5	3.313	6	3.273	9	2.870	9	3.371	3								
	SSF6	2.674	27	2.300	38	2.625	16	2.540	28								
	SSF7	2.663	28	2.509	29	2.744	14	2.614	26								
	SSF8	1.585	55	2.718	25	1.500	41	1.983	45								
GF	GF1	3.212	8	3.427	5	3.245	6	3.363	4	3.295	2	3.464	2	2.250	4	3.328	2
	GF2	2.953	21	3.136	15	2.125	19	2.997	18								
	GF3	1.943	42	2.264	39	2.000	21	2.058	40								
	GF4	3.238	7	3.482	2	3.240	7	3.357	5								
	GF5	3.161	12	3.264	10	2.748	12	3.248	9								
	GF6	3.187	11	3.227	12	1.750	28	3.164	11								
	GF7	3.160	13	3.118	16	1.875	23	3.113	13								
	GF8	3.036	15	3.282	8	1.874	24	3.093	14								
	GF9	3.378	4	3.445	4	3.235	8	3.354	6								
	GF10	1.974	41	2.145	47	1.499	42	2.023	42								
	GF11	2.358	30	2.545	27	1.375	52	2.399	30								
	GF12	1.839	49	1.873	57	1.498	43	1.842	53								
AF	AF1	2.083	35	2.200	44	2.624	17	2.138	36	2.212	7	2.427	5	2.000	5	2.283	7
	AF2	3.035	16	3.155	14	1.749	29	3.045	15								
	AF3	2.041	39	2.263	40	1.873	25	2.116	38								
	AF4	1.466	58	1.818	60	1.246	61	1.582	60								
	AF5	1.451	60	1.909	54	1.125	62	1.605	58								
E_ORF	E_ORF1	2.052	38	2.482	31	1.374	53	2.186	35	2.907	4	3.073	4	2.750	3	2.961	4
	E_ORF2	2.834	22	2.918	20	2.740	15	2.862	22								
	E_ORF3	2.684	26	3.245	11	2.375	18	2.875	20								
	E_ORF4	3.202	9	3.391	6	3.250	5	3.251	8								
	E_ORF5	2.813	23	2.864	21	1.872	26	2.807	24								
	E_ORF6	2.062	37	2.027	51	1.625	36	2.039	41								
	E_ORF7	2.228	33	2.435	34	1.748	30	2.289	33								
CRF	CRF1	3.109	14	2.964	18	1.870	27	3.026	16	2.378	5	2.200	8	1.999	6	2.305	6
	CRF2	3.342	5	2.827	22	2.750	10	3.148	12								
	CRF3	1.788	50	1.882	56	1.624	37	1.817	54								
	CRF4	1.902	44	1.936	53	1.497	44	1.904	49								
	CRF5	1.503	57	1.736	62	1.623	38	1.588	59								
ConRF	ConRF1	2.321	31	2.481	32	1.373	54	2.354	31	1.855	9	2.127	9	1.375	10	1.939	9
	ConRF2	1.849	47	2.136	48	1.250	57	1.936	47								
	ConRF3	1.850	46	2.073	50	1.372	55	1.916	48								
	ConRF4	1.591	54	1.836	59	1.249	58	1.669	56								
	ConRF5	1.601	53	1.900	55	1.248	59	1.698	55								
	ConRF6	1.394	62	1.809	61	1.124	63	1.534	62								
MRF	MRF1	2.974	18	2.655	26	1.747	31	2.830	23	2.326	6	2.400	6	1.625	8	2.334	5
	MRF2	2.694	25	2.364	36	2.124	20	2.563	27								
	MRF3	1.845	48	2.245	42	1.496	45	1.977	46								
	MRF4	2.275	32	2.418	35	1.495	46	2.305	32								
ERF	ERF1	2.580	29	2.508	30	1.746	32	2.534	29	2.031	8	2.300	7	1.750	7	2.116	8
	ERF2	1.922	43	2.227	43	1.494	47	2.019	43								
	ERF3	1.855	45	2.255	41	1.371	56	1.984	44								
	ERF4	2.964	19	2.809	23	1.493	48	2.871	21								
L_WRF	L_WRF1	1.450	61	1.727	63	1.745	33	1.556	61	1.694	10	1.955	10	1.624	9	1.788	10
	L_WRF2	2.959	20	2.945	19	1.999	22	2.929	19								
	L_WRF3	1.316	63	1.845	58	1.492	49	1.508	63								
E_UF	E_UF1	3.197	10	3.218	13	2.749	11	3.235	10	3.171	3	3.191	3	3.500	2	3.186	3
	E_UF2	1.461	59	1.955	52	1.622	39	1.640	57								
	E_UF3	1.684	52	2.182	46	1.621	40	1.859	51								
	E_UF4	1.710	51	2.191	45	1.491	50	1.875	50								
	E_UF5	2.078	36	2.544	28	1.744	34	2.235	34								
	E_UF6	2.026	40	2.355	37	1.743	35	2.135	37								
	E_UF7	2.109	34	2.100	49	1.490	51	2.090	39								
	E_UF8	3.034	17	2.991	17	2.745	13	3.023	17								
	E_UF9	3.482	3	3.327	7	3.375	4	3.350	7								

Note: R = Ranking.

Appendix D

Table A4. Correlation Matrix for the Delay Factors.

SSF	SSF1	SSF2	SSF3	SSF4	SSF5	SSF6	SSF7	SSF8
SSF1	1							
SSF2	0.653 **	1						
SSF3	0.714 **	0.630 **	1					
SSF4	*0.376* **	*0.225* **	*0.341* **	1				
SSF5	0.701 **	0.635 **	0.718 **	0.356 **	1			
SSF6	0.608 **	0.507 **	0.667 **	*0.274* **	0.725 **	1		
SSF7	0.572 **	0.510 **	0.560 **	*0.189* **	0.537 **	0.609 **	1	
SSF8	*0.372* **	*0.203* **	*0.371* **	*0.691* **	*0.319* **	*0.293* **	*0.159* **	1

E_ORF	E_ORF1	E_ORF2	E_ORF3	E_ORF4	E_ORF5	E_ORF6	E_ORF7
E_ORF1	1						
E_ORF2	0.129 *	1					
E_ORF3	0.230 **	0.317 **	1				
E_ORF4	0.210 **	0.327 **	0.411 **	1			
E_ORF5	0.396*	0.331 **	0.349 **	0.340 **	1		
E_ORF6	0.100	0.127*	0.164 **	0.238 **	0.177 **	1	
E_ORF7	0.229 **	0.350 **	0.330 **	0.276 **	0.451 **	0.397 **	1

GF	GF1	GF2	GF3	GF4	GF5	GF6	GF7	GF8	GF9	GF10	GF11	GF12
GF1	1											
GF2	0.545 **	1										
GF3	0.194 **	0.362 **	1									
GF4	0.240 **	0.173 **	0.168 **	1								
GF5	0.414 **	0.555 **	0.244 **	0.305 **	1							
GF6	0.504 **	0.476 **	0.228 **	0.305 **	0.645 **	1						
GF7	0.502 **	0.508 **	0.230 **	0.334 **	0.564 **	0.686 **	1					
GF8	0.486 **	0.440 **	0.269 **	0.358 **	0.489 **	0.742 **	0.648 **	1				
GF9	0.182 **	0.302 **	0.112*	0.278 **	0.159 **	0.258 **	0.304 **	0.342 **	1			
GF10	0.270 **	0.313 **	0.363 **	0.204 **	0.294 **	0.285 **	0.238 **	0.267 **	0.207 **	1		
GF11	0.235 **	0.235 **	0.124*	0.219 **	0.117*	0.239 **	0.268 **	0.311 **	0.349 **	0.264 **	1	
GF12	*0.004* **	0.076 **	0.321 **	0.130 *	0.175 **	0.106	0.016	0.105	*0.008*	0.460 **	0.085	1

MRF	MRF1	MRF2	MRF3	MRF4
MRF1	1			
MRF2	0.702 **	1		
MRF3	0.249 **	0.350 **	1	
MRF4	0.536 **	0.517 **	0.332 **	1

AF	AF1	AF2	AF3	AF4	AF5
AF1	1				
AF2	0.424 **	1			
AF3	0.443 **	0.377 **	1		
AF4	0.364 **	0.252 **	0.608 **	1	
AF5	0.403 **	0.369 **	0.588 **	0.681 **	1

L_WRF	L_WRF1	L_WRF2	L_WRF3
L_WRF1	1		
L_WRF2	0.284 **	1	
L_WRF3	0.624 **	0.190 **	1

E_UF	E_UF1	E_UF2	E_UF3	E_UF4	E_UF5	E_UF6	E_UF7	E_UF8	E_UF9
E_UF1	1								
E_UF2	0.131 *	1							
E_UF3	0.016	0.385 **	1						
E_UF4	0.092	0.360 **	0.602 **	1					
E_UF5	0.115 *	0.195 **	0.375 **	0.497 **	1				
E_UF6	0.256 **	0.324 **	0.287 **	0.429 **	0.531 **	1			
E_UF7	0.187 **	0.058	0.172 **	0.314 **	0.237 **	0.454 **	1		
E_UF8	0.282 **	0.132*	0.111	0.259 **	0.166 **	0.274 **	0.159 **	1	
E_UF9	0.348 **	*0.106*	*0.079*	0.045	0.064	0.192 **	0.192 **	0.521 **	1

ERF	ERF1	ERF2	ERF3	ERF4
ERF1	1			
ERF2	0.575 **	1		
ERF3	0.343 **	0.570 **	1	
ERF4	0.387 **	0.325 **	0.347 **	1

ConRF	ConRF1	ConRF2	ConRF3	ConRF4	ConRF5	ConRF6
ConRF1	1					
ConRF2	0.779 **	1				
ConRF3	0.760 **	0.834 **	1			
ConRF4	0.568 **	0.698 **	0.739 **	1		
ConRF5	0.537 **	0.639 **	0.669 **	0.662 **	1	
ConRF6	0.425 **	0.504 **	0.475 **	0.590 **	0.580 **	1

CRF	CRF1	CRF2	CRF3	CRF4	CRF5
CRF1	1				
CRF2	0.535 **	1			
CRF3	0.332 **	0.378 **	1		
CRF4	0.285 **	0.274 **	0.807 **	1	
CRF5	0.195 **	0.220 **	0.675 **	0.673 **	1

** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed), Note: Italic values indicate negative correlations.

References

1. International Energy Agency. Key World Energy Statistics. Available online: http://www.iea.org/publications/freepublications/publication/KeyWorld2014.pdf (accessed on 18 May 2017).
2. Hirst, E.; Kirby, B. Key Transmission Planning Issues. *Electr. J.* **2001**, *14*, 59–70. [CrossRef]
3. Liu, J.; Niu, D.; Song, X. The energy supply and demand pattern of China: A review of evolution and sustainable development. *Renew. Sustain. Energy Rev.* **2013**, *25*, 220–228. [CrossRef]
4. Gharaibeh, H.M. Managing the Cost of Power Transmission Projects: Lessons Learned. *J. Constr. Eng. Manag.* **2013**, *139*, 1063–1067. [CrossRef]
5. Pall, G.K.; Bridge, A.J.; Skitmore, M.; Gray, J. Comprehensive review of delays in power transmission projects. *IET Gener. Transm. Distrib.* **2016**, *10*, 3393–3404. [CrossRef]
6. Gordon-Watt, M. Project management in the powerline construction industry. *Mag. S. Afr. Inst. Civ. Eng.* **2009**, *17*, 59.
7. Wu, F.F.; Zheng, F.L.; Wen, F.S. Transmission investment and expansion planning in a restructured electricity market. *Energy* **2006**, *31*, 954–966. [CrossRef]
8. Zahedi, G.; Azizi, S.; Bahadori, A.; Elkamel, A.; Alwi, S.R.W. Electricity demand estimation using an adaptive neuro-fuzzy network: A case study from the Ontario province—Canada. *Energy* **2013**, *49*, 323–328. [CrossRef]
9. Ciupuliga, A.R.; Gibescu, M. *Review of Existing Transmission Planning and Approval Proceduresand Coordination of Infrastructure Developments between TSOs*; EU: Brussels, Belgium, 2010.
10. Furby, L.; Slovic, P.; Fischhoff, B.; Gregory, R. Public perceptions of electric power transmission lines. *J. Environ. Psychol.* **1988**, *8*, 19–43. [CrossRef]
11. Kirby, B.; Hirst, E. Maintaining Transmission Adequacy in the Future. *Electr. J.* **1999**, *12*, 62–72. [CrossRef]
12. Ciupuliga, A.R.; Cuppen, E. The role of dialogue in fostering acceptance of transmission lines: The case of a France–Spain interconnection project. *Energy Policy* **2013**, *60*, 224–233. [CrossRef]
13. Davis, S. Renewable Electricity Generation and Transmission Expansion: A Federal, State or Regional Approach? *Electr. J.* **2015**, *28*, 28–35. [CrossRef]
14. Zhao, H.; Li, N. Risk Evaluation of a UHV Power Transmission Construction Project Based on a Cloud Model and FCE Method for Sustainability. *Sustainability* **2015**, *7*, 2885–2914. [CrossRef]
15. Zhao, H.; Guo, S. Risk Evaluation on UHV Power Transmission Construction Project Based on AHP and FCE Method. *Math. Probl. Eng.* **2014**, *2014*, 687568. [CrossRef]
16. Flyvbjerg, B.; Garbuio, M.; Lovallo, D. Delusion and Deception in Large Infrastructure Projects: Two Models for Explaining and Preventing Executive Disaster. *Calif. Manag. Rev.* **2009**, *51*, 170–193. [CrossRef]
17. Batool, A.; Abbas, F. Reasons for delay in selected hydro-power projects in Khyber Pakhtunkhwa (KPK), Pakistan. *Renew. Sustain. Energy Rev.* **2017**, *73*, 196–204. [CrossRef]
18. Pillai, N.V.; Kannan, K.P. Time and Cost Overruns of the Power Projects in Kerala. *J. Soc. Econ. Dev.* **2002**, *4*, 148–169.
19. Yau, N.-j.; Yang, J.-b. Factors causing design schedule delays in turnkey projects in Taiwan: An empirical study of power distribution substation projects. *Proj. Manag. J.* **2012**, *43*, 50–61. [CrossRef]
20. Al-Momani, A.H. Construction delay: A quantitative analysis. *Int. J. Proj. Manag.* **2000**, *18*, 51–59. [CrossRef]
21. Durdyev, S.; Omarov, M.; Ismail, S. Causes of delay in residential construction projects in Cambodia. *Cogent Eng.* **2017**, *4*, 1291117. [CrossRef]
22. Sweis, G.; Sweis, R.; Abu Hammad, A.; Shboul, A. Delays in construction projects: The case of Jordan. *Int. J. Proj. Manag.* **2008**, *26*, 665–674. [CrossRef]
23. Koushki, P.A.; Al-Rashid, K.; Kartam, N. Delays and cost increases in the construction of private residential projects in Kuwait. *Constr. Manag. Econ.* **2005**, *23*, 285–294. [CrossRef]
24. Hamzah, N.; Khoiry, M.A.; Arshad, I.; Tawil, N.M.; Che Ani, A.I. Cause of Construction Delay—Theoretical Framework. *Procedia Eng.* **2011**, *20*, 490–495. [CrossRef]
25. Asiedu, R.O.; Alfen, H.W. Understanding the underlying reasons behind time overruns of government building projects in Ghana. *KSCE J. Civ. Eng.* **2016**, *20*, 2103–2111. [CrossRef]
26. Assaf, S.A.; Al-Khalil, M.; Al-Hazmi, M. Causes of Delay in Large Building Construction Projects. *J. Manag. Eng.* **1995**, *11*, 45–50. [CrossRef]
27. Aibinu, A.A.; Odeyinka, H.A. Construction delays and their causative factors in nigeria. *J. Constr. Eng. Manag.* **2006**, *132*, 667–677. [CrossRef]

28. Ogunlana, S.O.; Promkuntong, K.; Jearkjirm, V. Construction delays in a fast-growing economy: Comparing Thailand with other economies. *Int. J. Proj. Manag.* **1996**, *14*, 37–45. [CrossRef]
29. Amoatey, C.T.; Ameyaw, Y.A.; Adaku, E.; Famiyeh, S. Analysing delay causes and effects in Ghanaian state housing construction projects. *Int. J. Manag. Proj. Bus.* **2015**, *8*, 198–214. [CrossRef]
30. Alwi, S.; Hampson, K.D. Identifying the important causes of delays in bulding construction projects. In Proceedings of the 9th East Asia-Pacific Conference on Structural Engineering and Construction, Bali, Indonesia, 16–18 December 2003; pp. 1–7.
31. Islam, M.S.; Trigunarsyah, B.; Hassanain, M.; Assaf, S. Causes of Delay in Construction Projects in Bangladesh. In Proceedings of the 6th International Conference on Construction Engineering and Project Management, Busan, Korea, 11–14 October 2015.
32. Alaghbari, W.e.; Razali, A.; Kadir, M.; Salim, A.; Ernawati. The significant factors causing delay of building construction projects in Malaysia. *Eng. Constr. Archit. Manag.* **2007**, *14*, 192–206. [CrossRef]
33. Kumaraswamy, M.M.; Chan, D.W.M. Contributors to construction delays. *Constr. Manag. Econ.* **1998**, *16*, 17–29. [CrossRef]
34. Abd El-Razek, M.E.; Bassioni, H.A.; Mobarak, A.M. Causes of Delay in Building Construction Projects in Egypt. *J. Constr. Eng. Manag.* **2008**, *134*, 831–841. [CrossRef]
35. Le-Hoai, L.; Lee, Y.; Lee, J. Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. *KSCE J. Civ. Eng.* **2008**, *12*, 367–377. [CrossRef]
36. Odeh, A.M.; Battaineh, H.T. Causes of construction delay: Traditional contracts. *Int. J. Proj. Manag.* **2002**, *20*, 67–73. [CrossRef]
37. Chan, D.W.M.; Kumaraswamy, M.M. A comparative study of causes of time overruns in Hong Kong construction projects. *Int. J. Proj. Manag.* **1997**, *15*, 55–63. [CrossRef]
38. Kaming, P.F.; Olomolaiye, P.O.; Holt, G.D.; Harris, F.C. Factors influencing Construction cost and time overruns on high-rise projects in Indonesia. *Constr. Manag. Econ.* **1997**, *15*, 83–94. [CrossRef]
39. Agyakwah-Baah, A.B.; Fugar, F.D.K. Delays in Building Construction Projects in Ghana. *Australas. J. Constr. Econ. Build.* **2010**, *10*, 103–116.
40. Hong Pham, L.; Hadikusumo, H. Schedule delays in engineering, procurement, and construction petrochemical projects in Vietnam. *Int. J. Energy Sect. Manag.* **2014**, *8*, 3–26. [CrossRef]
41. Ruqaishi, M.; Bashir, H.A. Causes of Delay in Construction Projects in the Oil and Gas Industry in the Gulf Cooperation Council Countries: A Case Study. *J. Manag. Eng.* **2015**, *31*, 5014017. [CrossRef]
42. Fallahnejad, M.H. Delay causes in Iran gas pipeline projects. *Int. J. Proj. Manag.* **2013**, *31*, 136–146. [CrossRef]
43. Seung, H.H.; Sungmin, Y.; Hyoungkwan, K.; Young, H.K.; Hyung, K.K.; Sang, H.H. Analyzing Schedule Delay of Mega Project: Lessons Learned From Korea Train Express. *IEEE Trans. Eng. Manag.* **2009**, *56*, 243–256.
44. Amoatey, C.T.; Alfred Nii Okanta, A. Exploring critical road project delay factors in Ghana. *J. Facil. Manag.* **2017**, *15*, 110. [CrossRef]
45. Soeng, S.; Santoso, D.S. Analyzing Delays of Road Construction Projects in Cambodia: Causes and Effects. *J. Manag. Eng.* **2016**, *32*, 5016020. [CrossRef]
46. Aziz, R.F.; Abdel-Hakam, A.A. Exploring delay causes of road construction projects in Egypt. *Alex. Eng. J.* **2016**, *55*, 1515–1539. [CrossRef]
47. Aditya, A.K.; Douglass, D.A.; Bhattacharya, M. Urban Infrastructure Development Works in India: Delay and Difficulties in Implementation with Reference to a Water Supply Project. *J. Inst. Eng. (India) Ser. A* **2017**, *98*, 349–354. [CrossRef]
48. Bruland, A.; Dmaidi, N.; Mahamid, I. Causes of Delay in Road Construction Projects. *J. Manag. Eng.* **2012**, *28*, 300–310. [CrossRef]
49. Kaliba, C.; Muya, M.; Mumba, K. Cost escalation and schedule delays in road construction projects in Zambia. *Int. J. Proj. Manag.* **2009**, *27*, 522–531. [CrossRef]
50. Mansfield, N.R.; Ugwu, O.O.; Doran, T. Causes of delay and cost overruns in Nigerian construction projects. *Int. J. Proj. Manag.* **1994**, *12*, 254–260. [CrossRef]
51. Meeampol, S.; Ogunlan, S.O. Factors affecting cost and time performance on highway construction projects: Evidence from Thailand. *J. Financ. Manag. Prop. Constr.* **2006**, *11*, 3–20. [CrossRef]
52. Alinaitwe, H.; Apolot, R.; Tindiwensi, D. Investigation into the Causes of Delays and Cost Overruns in Uganda's Public Sector Construction Projects. *J. Constr. Dev. Ctries.* **2013**, *18*, 33–47.

53. Aigbavboa, C.O.; Thwala, W.D.; Mukuka, M.J. Construction project delays in Lusaka, Zambia: Causes and effects. *J. Econ. Behav. Stud.* **2014**, *6*, 848–857.
54. Yang, J.-B.; Wei, P.-R. Causes of Delay in the Planning and Design Phases for Construction Projects. *J. Archit. Eng.* **2010**, *16*, 80–83. [CrossRef]
55. Babatunde, S.O.; Adeniyi, O.; Awodele, O.A. Investigation into the causes of delay in land acquisition for PPP projects in developing countries. *J. Eng. Des. Technol.* **2017**, *15*, 552. [CrossRef]
56. Skitmore, M.; Al-Kharashi, A. Causes of delays in Saudi Arabian public sector construction projects. *Constr. Manag. Econ.* **2009**, *27*, 3–23. [CrossRef]
57. Enshassi, A.; Al-Najjar, J.; Kumaraswamy, M. Delays and cost overruns in the construction projects in the Gaza Strip. *J. Financ. Manag. Prop. Constr.* **2009**, *14*, 126–151. [CrossRef]
58. Mohammed, K.A.; Isah, A.D. Causes of delay in Nigeria construction industry. *Interdiscip. J. Contemp. Res. Bus.* **2012**, *4*, 785–794.
59. Assaf, S.A.; Al-Hejji, S. Causes of delay in large construction projects. *Int. J. Proj. Manag.* **2006**, *24*, 349–357. [CrossRef]
60. Mahamid, I.; Al-Ghonamy, A.; Aichouni, M. Risk matrix for delay causes in construction projects in Saudi Arabia. *Res. J. Appl. Sci. Eng. Technol.* **2015**, *9*, 665–670. [CrossRef]
61. Yang, J.B.; Ou, S.F. Using structural equation modeling to analyze relationships among key causes of delay in construction. *Can. J. Civ. Eng.* **2008**, *35*, 321–332. [CrossRef]
62. Toor, S.U.R.; Ogunlana, S. Problems causing delays in major construction projects in Thailand. *Constr. Manag. Econ.* **2008**, *26*, 395–408. [CrossRef]
63. Ulubeyli, S.; Tuncbilekli, N.; Kazaz, A. Causes of Delays in Construction Projects in Turkey. *J. Civ. Eng. Manag.* **2012**, *18*, 426. [CrossRef]
64. Faridi, A.S.; El-Sayegh, S.M. Significant factors causing delay in the UAE construction industry. *Constr. Manag. Econ.* **2006**, *24*, 1167–1176. [CrossRef]
65. Pai, S.K.; Bharath, J.R. Analysis of Critical Causes of Delays in Indian Infrastructure Projects. *Int. J. Innov. Res. Dev.* **2013**, *2*, 251–263.
66. Morris, S. Cost and Time Overruns in Public Sector Projects. *Econ. Political Wkly.* **1990**, *25*, 154–168.
67. Venkatesh, M.P.; Renuka, S.M.; Umarani, C. *Causes of Delay in Indian Construction Industry*; Trans. Tech. Publications: Zurich, Switzerland, 2012; pp. 2768–2773.
68. Khoshgoftar, M.; Bakar, A.H.A.; Osman, O. Causes of delays in Iranian construction projects. *Int. J. Constr. Manag.* **2010**, *10*, 53–69. [CrossRef]
69. Bekr, G.A. Causes of delay in public construction projects in Iraq. *Jordan J. Civ. Eng.* **2015**, *9*, 149–162.
70. Mezher, T.M.; Tawil, W. Causes of delays in the construction industry in Lebanon. *Eng. Constr. Archit. Manag.* **1998**, *5*, 252–260. [CrossRef]
71. Tawil, N.M.; Khoiry, M.A.; Hamzah, N.; Arshad, I.; Badaruzzaman, W.H.W. A Pilot Survey on Causes of Delay in Malaysian Construction Project. *MATEC Web Conf.* **2014**, *15*, 01010. [CrossRef]
72. Ramanathan, C.T.; Narayanan, S.P. A Comparative Study among Stakeholders on Causes of Time delay in Malaysian Multiple Design and Build Projects. In Proceedings of the IEEE International Conference on Industrial Engineering and Engineering Management, Bandar Sunway, Malaysia, 9–12 December 2014; pp. 458–463.
73. Riazi, M.; Riazi, S.; Lamari, F. Public sector project delay: The Malaysian perspective and the way forward. In Proceedings of the 19th CIB World Building Congress, Brisbane, Australia, 5–9 May 2013.
74. Sambasivan, M.; Soon, Y.W. Causes and effects of delays in Malaysian construction industry. *Int. J. Proj. Manag.* **2007**, *25*, 517–526. [CrossRef]
75. Shahhossein, V.; Afshar, M.R.; Amiri, O. The Root Causes of Construction Project Failure. *Sci. Iran.* **2017**. [CrossRef]
76. Angelidi, A. Delays in Construction Projects in Greece: Causes, Effects and Project Management Tools. Ph.D. Thesis, University College London, London, UK, 2007.
77. Lo, T.Y.; Fung, I.W.; Tung, K.C. Construction Delays in Hong Kong Civil Engineering Projects. *J. Constr. Eng. Manag.* **2006**, *132*, 636–649. [CrossRef]
78. Yang, J.B.; Yang, C.C.; Kao, C.K. Evaluating schedule delay causes for private participating public construction works under the Build-Operate-Transfer model. *Int. J. Proj. Manag.* **2010**, *28*, 569–579. [CrossRef]

79. Ahsan, K.; Gunawan, I. Analysis of cost and schedule performance of international development projects. *Int. J. Proj. Manag.* **2010**, *28*, 68–78. [CrossRef]
80. Marzouk, M.M.; El-Rasas, T.I. Analyzing delay causes in egyptian construction projects. *J. Adv. Res.* **2014**, *5*, 49–55. [CrossRef] [PubMed]
81. Aziz, R.F. Ranking of delay factors in construction projects after Egyptian revolution. *Alex. Eng. J.* **2013**, *52*, 387–406. [CrossRef]
82. Joseph, I.T.B.; Augustine, K.M.; Theophilus, A.K. Delays to Large Construction Projects in Ghana: A Risk Overview. *J. Civ. Eng. Archit.* **2014**, *8*, 367–377.
83. Doloi, H.; Sawhney, A.; Iyer, K.C. Structural equation model for investigating factors affecting delay in Indian construction projects. *Constr. Manag. Econ.* **2012**, *30*, 869–884. [CrossRef]
84. Doloi, H.; Sawhney, A.; Iyer, K.C.; Rentala, S. Analysing factors affecting delays in Indian construction projects. *Int. J. Proj. Manag.* **2012**, *30*, 479–489. [CrossRef]
85. Adam, A.; Josephson, P.-E.B.; Lindahl, G. Aggregation of factors causing cost overruns and time delays in large public construction projects: Trends and implications. *Eng. Constr. Archit. Manag.* **2017**, *24*, 393–406. [CrossRef]
86. Samarghandi, H.; Tabatabaei, S.M.M.; Taabayan, P.; Hashemi, A.M.; Willoughby, K. Studying the reasons for delay and cost overrun in construction projects: The case of Iran. *J. Constr. Dev. Ctries.* **2016**, *21*, 51–84. [CrossRef]
87. Abu Hassan, M.H.A. *Causes of Delay in Construction Projects*; ProQuest Dissertations Publishing: Doha, Qatar, 2016.
88. Rao, B.P.; Shekar, S.C.; Jaiswal, N.; Jain, A.; Saxena, A.D. Delay Analysis of Construction Projects. *J. Inf. Technol. Econ. Dev.* **2016**, *7*, 15.
89. Arantes, A.; da Silva, P.F.; Ferreira, L.M.D.F. Delays in construction projects—causes and impacts. In Proceedings of the 6th IESM Conference, Seville, Spain, 21–23 October 2015; pp. 1105–1110.
90. Bagaya, O.; Song, J. Empirical Study of Factors Influencing Schedule Delays of Public Construction Projects in Burkina Faso. *J. Manag. Eng.* **2016**, *32*, 5016014. [CrossRef]
91. Manzur, A.; Ganesan, N.; Vinay, M. A Study on Delays in Construction Projects. *Appl. Mech. Mater.* **2016**, *857*, 24–29. [CrossRef]
92. Lindhard, S.M.; Shen, G.Q.; Brunoe, T.D.; Larsen, J.K. Factors Affecting Schedule Delay, Cost Overrun, and Quality Level in Public Construction Projects. *J. Manag. Eng.* **2016**, *32*, 4015032. [CrossRef]
93. Kim, S.-Y.; Tuan, K.N.; Luu, V.T. Delay factor analysis for hospital projects in Vietnam. *KSCE J. Civ. Eng.* **2016**, *20*, 519–529. [CrossRef]
94. Oyegoke, A.S.; Kiyumi, N.A. The causes, impacts and mitigations of delay in megaprojects in the Sultanate of Oman. *J. Financ. Manag. Prop. Constr.* **2017**, *22*, 286–302. [CrossRef]
95. Sambasivan, M.; Deepak, T.J.; Salim, A.N.; Ponniah, V. Analysis of delays in Tanzanian construction industry Transaction cost economics (TCE) and structural equation modeling (SEM) approach. *Eng. Constr. Archit. Manag.* **2017**, *24*, 308–325. [CrossRef]
96. Mpofu, B.; Ochieng, E.G.; Moobela, C.; Pretorius, A. Profiling causative factors leading to construction project delays in the United Arab Emirates. *Eng. Constr. Archit. Manag.* **2017**, *24*, 346–376. [CrossRef]
97. Kumar, S. Schedule and cost overrun analysis for R&D projects using ANP and system dynamics. *Int. J. Qual. Reliab. Manag.* **2017**, *34*, 1551–1567. [CrossRef]
98. Jalal, M.P.; Shoar, S. A hybrid SD-DEMATEL approach to develop a delay model for construction projects. *Eng. Constr. Archit. Manag.* **2017**, *24*, 629–651. [CrossRef]
99. Georgy, M.; Kadry, M.; Osman, H. Causes of Construction Delays in Countries with High Geopolitical Risks. *J. Constr. Eng. Manag.* **2017**, *143*, 4016095. [CrossRef]
100. Famiyeh, S.; Amoatey, C.T.; Adaku, E.; Agbenohevi, C.S. Major causes of construction time and cost overruns: A case of selected educational sector projects in Ghana. *J. Eng. Des. Technol.* **2017**, *15*, 181. [CrossRef]
101. Oluwole, A. Overrun causations under advance payment regimes. *Built Environ. Proj. Asset Manag.* **2017**, *7*, 86–98. [CrossRef]
102. Agyekum-Mensah, G.; Knight, A.D. The professionals' perspective on the causes of project delay in the construction industry. *Eng. Constr. Archit. Manag.* **2017**, *24*, 828–841. [CrossRef]
103. Hassan, A.; Rahman, M.S.; Khan, F.T.; Malik, M.B.; Ali, M.Z. Electricity Challenge for Sustainable Future in Bangladesh. *APCBEE Procedia* **2012**, *1*, 346–350. [CrossRef]

104. Ministry of Power Energy & Mineral Resources (MPEMR). *Power Sector Master Plan 2010 (PSMP)*; MPEMR: Dhaka, Bangladesh, 2015.
105. Power Division, G.o.B. Allocated/Forecasted Budget for Power Division in Bangladesh. Available online: http://www.powerdivision.gov.bd/site/page/47f755ca-ecd3-4a85-a750-17645a7f537b/Annual-Budget (accessed on 18 May 2017).
106. PGCB. *Annual Report 2015–2016*; Power Grid Company of Bangladesh Ltd. (PGCB): Dhaka, Bangladesh, 20 November 2016.
107. Asian Development Bank (ADB). Power System Efficiency Improvement Program. Available online: https://www.adb.org/sites/default/files/linked-documents/37113-013-ban-ssa.pdf (accessed on 22 October 2017).
108. Karaban, E. *World Bank Supports Bangladesh in Modernizing the Power Sector*; The World Bank: Washington, DC, USA, 2017.
109. TDS. Focus on Financing Power Projects. HSBC: Powering Bangladesh. *The Daily Star*, 19 April 2017.
110. ENB. Bangladesh mulls to import power from Myanmar and China. *Energy News Bangladesh*, 20 April 2017.
111. Plama, M. Cross-border energy trade. *The Kathmandu Post*, 26 April 2017.
112. IAEA. *Country Nuclear Power Profiles*; International Atomic Energy Agency: Vienna, Austria, 2016.
113. ENB. No proposal to be taken without tender for solar power plant project. *Energy News Bangladesh*, 10 June 2017.
114. PGCB. G2G Contract to Strengthen Power Grid Network under PGCB. Available online: https://www.pgcb.org.bd/PGCB/?a=pages/latest_news_details.php&id=57 (accessed on 3 November 2017).
115. Implementation Monitoring and Evaluation Division (IMED). Projects List. Available online: http://www.imed.gov.bd/site/page/eb9709ff-7344-42cb-8f4c-9df7e5b08ba2/ (accessed on 19 June 2017).
116. Esterman, A. The Likert Scale. *Australas. Epidemiol.* **2003**, *10*, 46–48.
117. NHMRC. National Statement on Ethical Conduct in Human Research 2007 (Updated 2018). Available online: http://www.nhmrc.gov.au/guidelines/publications/e72 (accessed on 23 November 2019).
118. Memon, A.H.; Rahman, I.A.; Akram, M.; Ali, N.M. Significant Factors Causing Time Overrun in Construction Projects of Peninsular Malaysia. *Mod. Appl. Sci.* **2014**, *8*, 16–28. [CrossRef]
119. Doloi, H. Analysis of pre-qualification criteria in contractor selection and their impacts on project success. *Constr. Manag. Econ.* **2009**, *27*, 1245–1263. [CrossRef]
120. Kaplan, S.M. *Electric Power Transmission: Background and Policy Issues*; Congressional Research Service: Washington, DC, USA, 2009.
121. Aibinu, A.A.; Jagboro, G.O. The effects of construction delays on project delivery in Nigerian construction industry. *Int. J. Proj. Manag.* **2002**, *20*, 593–599. [CrossRef]
122. Electrical Power Energy. How to Manage Right of Way in Power Transmission Line. Available online: http://www.electricalpowerenergy.com/2014/08/08/how-to-manage-right-of-way-in-power-transmission-line/ (accessed on 22 November 2018).
123. Ministry of Law. The Electricity Act, 1910. Available online: http://bdlaws.minlaw.gov.bd/print_sections_all.php?id=93 (accessed on 22 November 2017).
124. Manavazhi, M.R.; Adhikari, D.K. Material and equipment procurement delays in highway projects in Nepal. *Int. J. Proj. Manag.* **2002**, *20*, 627–632. [CrossRef]
125. Prokopp, C. Hartals Drain Bangladesh's Potential. Available online: http://www.clickittefaq.com/hartals-drain-bangladeshs-potential/ (accessed on 22 March 2017).
126. Majid, I.A. Causes and Effets of Delays in Aceh Construction Industry. Ph.D. Thesis, University of Technology Malaysia, Iskandar Puteri, Malaysia, 2006.
127. Pillai, N.V.; Kannan, K.P. *Time and Cost Overruns of the Power Projects in Kerala*; Centre for Development Studies: Thiruvananthapuram, India, 2001.