A RISK ANALYSIS OF CONSTRUCTION PROJECTS DELAY FACTORS IN THE UNITED KINGDOM

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ABSTRACT

Project time overruns is a recurring challenge in the construction industry. This paper mainly identified the causes of construction project delays, analysed the probability and impact of occurrence, and ranked the risk factors. The identified factors are categorised into Client, Consultant, Contractor, and External related factors. To achieve the research objective, the identified delay factors were part of a questionnaire survey; and responses were yielded from building construction experts in the United Kingdom. The relative importance index (RII) method was applied to prioritise the probability and impact of project delay factors and determine the risk level. In the four categories, delay in decision-making and order issuance by the client, variation and changes in design, delay in the approval of drawings, and delay in design preparation and late revision of designs are some of the identified top-ranking risks. In addition, the delay in providing utilities, construction mistakes, defective works and rework, adverse weather conditions, and delays or issues regarding permissions and statutory approvals are among the top-ranking risks. This research is expected to significantly contribute to and improve the understanding and perception of the risks posed by the various delay factors, especially in the building construction industry.

Keywords: Construction, United Kingdom, Project, Time, Delays, Risks

INTRODUCTION

Activities in the construction industry account for 6.7% (equating to over 90 billion pounds) of the Gross Value Addition (GVA) of the UK's economy (Department for Business Innovation & Skills, 2012). The industry sector has over 280,000 businesses and employs 2.93million jobs, equivalent to 10% of the UK job market (Department for Business, Innovation and Skills, 2013). However, Latham (1994) suggests the need for the industry to improve and be more productive. Indeed, a global challenge for the construction industry is time overruns. A study of 250 projects by Catalão, Cruz and Sarmento (2021) concluded that 42.6% of construction projects experience time delays. In the UK, based on the UK Industry Performance Reports, between 2003 and 2018, an average of 42.1% of construction projects experienced time overruns, while an average of 46.1% of construction projects experienced cost overruns (Bryer *et al*., 2018).

The reasons for poor project duration performance are numerous, diverse, and perhaps, inexhaustive, depending on the nature of the project and the country where the project is situated. The risks posed by these delay factors must be understood to enable the project leads or senior management team to arrange the appropriate strategies and responses to mitigate the risks as part of the crucial steps to reducing the chance of project time overruns.

Therefore, this research aims to study the factors that cause project delays and determine their risk level.

LITERATURE REVIEW

According to Johnson and Babu (2020), the success of a project is measured mainly by its ability to complete on time and under budget while maintaining top quality. Therefore, time or project duration is an essential constraint of construction project management. Construction project duration is the period required to perform the work as outlined in the employer's requirement in the contract (Mahamid, 2019). However, project delay is a recurring challenge (Catalão, Cruz and Sarmento, 2021). It is often argued that the different, dynamic, and wide range of risks with inter, and various cultural backgrounds (Acharya, Lee and Kim, 2006) underlies the unpredictability of projects in the industry. Furthermore, construction activities are highly interconnected and are imposed upon by multi-criteria set of success factors which pose challenges to construction firms (Turkyilmaz, *et al*., 2019). As a result, the factors that cause project delays have been studied and are numerous. Some examples of delay factors are shown in Table 1

TABLE 1: Examples of Delay Factors

Examples of Delay Factors		
S/No	**Factors**	**Authors**
1	Client financial difficulties and delays in payments to contractor	Famiyeh *et al*. (2017); Hasan and Mohammed (2018); Rahman *et al*. (2022)
2	Delay in decision-making and order issuance by the client	Umar, Al Rizeiqi and Badr (2020); Hoque *et al* (2021); Rahman *et al* (2022)
3	Adverse weather condition	Famiyeh *et al* (2017); Oyegoke and Al Kiyumi (2017); Hasan and Mohammed (2018)
4	Unrealistic contract duration imposed by owner	Prasad *et al* (2019); Famiyeh *et al* (2017); Hasan and Mohammed (2018)
5	Frequent changes in the design criteria provided by the employer	Haslinda *et al* (2018); Famiyeh *et al* (2017); Prasad *et al* (2019)
6	Incompetent or inadequate experience of design team	Famiyeh *et al* (2017); Ullah *et al*. (2017); Rahman *et al* (2022)
7	Construction mistakes, defective works, and rework	Prasad *et al* (2019); Hoque *et al* (2021); Umar, Al Rizeiqi and Badr (2020)
8	Delay in providing utilities	Rahman *et al* (2022)

9	Shortage of quality materials in the market and shortage of suppliers	Famiyeh *et al* (2017); Umar, Al Rizeiqi and Badr (2020); Hoque *et al* (2021)
10	Variation orders or changes of the scope by the owner during construction	Hasmori *et al* (2018); Hoque *et al* (2021)

From the study of previous pieces of literature, the theoretical conceptualisation by Jelodar, Raut and Saghatforoush (2021) focused on the classification of the cause and sources of building project delays based on the information identified in previous studies. The delay causes were classified into four categories - delay caused by the owner (client), contractor, consultant, and external factors. Hasmori *et al*. (2018) and Hasan and Mohammed (2018) categorised delay factors similarly. Other authors have applied different categorisations. For instance, Famiyeh *et al*. (2017), in addition to these four categories, included Government actions-related delay factors, material-related delay factors, and contractual-related delay factors. Also, Hoque *et al*. (2021) included design, equipment, materials, and labour-related categories. But Mahamid (2017) limited the categorisation to contractors' and consultants' delay factors only. Others like Johnson and Babu (2020), Namous and Al Battah (2021), and Sharma, Gupta and Khitoliya (2021) did not put the delay factors into any category.

The study of the existing literature also found that the investigation by different authors relates to peculiar challenges of the regions and construction sub-sector where the studies were undertaken. The spread shows oil and gas construction in Yemen (Kassem, Khoiry, and Hamzah, 2020), building projects in Saudi Arabia (Mahamid, 2017), construction mega-projects in the United Arab Emirate (Rahman *et al*., 2022), highway projects in Northern India (Sharma, Gupta and Khitoliya, 2021), Bangladeshi construction industry (Hoque *et al*., 2021), building construction in New Zealand (Jelodar, Raut and Saghatforoush, 2021), etc.

Besides categorising these factors, most researchers have attempted to rank these delays. For instance, the findings by Famiyeh *et al*. (2017) indicate that the client-related factors have the highest impact on project delays, followed by the contractor-related and consultant-related factors. But in a different categorisation, Mahamid (2017) concludes that political situation, payments delay by the owner, lack of communication between construction parties, frequent change orders, and unexpected ground and terrain conditions are among the top five delay factors. Other studies and ranking by Haslinda *et al*. (2018), Prasad *et al*. (2019), Zafar *et al*. (2019), Johnson and Babu (2020), Umar, Al Rizeiqi and Badr (2020), Namous and Al Battah (2021), and Rahman *et al*. (2022) arrived at different ranking conclusions. Oyegoke and Al Kiyumi (2017); Gebrehiwet and Luo (2017); Famiyeh *et al*. (2017); Othman, Shafiq and Nuruddin (2017); Hasan and Mohammed (2018), among others, all used the Relative Importance Index (RII) to identify the degree of importance of the delay factors. Other methods are sometimes adopted, like Renuka, Kamal and Umarani (2017), who assumed the Statistical mean and standard deviation approach. However, the RII method remains the most used ranking approach.

From the comprehensive literature review of previous studies, the delay factors from various sources were identified and categorised into the client, consultant, contractor, and external related factors. This categorisation is consistent with that adopted by Hasan and Mohammed (2018), Hasmori *et al*. (2018), and Jelodar, Raut and Saghatforoush (2021) because it provides a clear and straightforward classification of the delay factors. Also, this approach to investigating these delay factors is adopted because most researchers have studied the general causes of delays with limited focus on specific categorisation. As a result, the delay factors examined are often not comprehensive. Besides, most researchers limited their studies to ranking delay factors based on primarily the likelihood of their occurrence. However, this study addresses the risk by investigating the probability and impact of the occurrence of these delay factors. Also, this study addresses delay factors in UK construction; other studies appear to focus on other countries and regions. Therefore, from the examined pieces of literature, in the client-related factors category, 42 delay factors were identified; in the consultant-related factors category, 45 delay factors were identified. Also, in the contractor-related factors category, 55 delay factors were identified; and in the external-related factors category, 24 delay factors were identified.

METHODOLOGY

This section explains the research method used in the questionnaire design, the data-collection sampling method, and the analytical procedures adopted for the work. Mixed-method research was used for this study. Due to the many numbers of factors identified in each category of the delay factors, it was important to harmonise and reduce the number to a manageable level for the survey questionnaires. Therefore, in advance of data collection, a preliminary study was conducted by interviewing four experienced personnel in the construction industry to validate the contents of the questionnaires and confirm the relevancy of the issues to be investigated. This interview process resulted in 29, 28, 33, and 20 delay factors in the client-related, consultant-related, contractor-related, and external-related factors categories, respectively. Following this, a survey questionnaire was used to collect data. A survey questionnaire was adopted to enable a considerable sample size to respond to the number of identified delay factors and rate them quickly and easily instead of a face-to-face interview, which would be very time-consuming. Four questionnaires were generated for each category. Also, for each category, the respondents must respond to both the probability and impact of the identified delay factor.

The four questionnaires were structured in two sections. The first section was intended to gather information about the respondents' profiles; the second relates to questions about the four delay factors categories. In the second section, the participants were required to respond to the Likert scale for both the factors' probability and impact. For the probability category of questions, an ordinal scale was adopted where 1= Never, 2= Rarely, 3= Sometimes, 4= Very Often, and 5= Always. Also, an ordinal scale was adopted for the impact category of questions where 1= Not at all, 2= Slightly, 3= Moderately, 4= Very, and 5= Extremely.

The credibility of the results of these surveys is hinged on the level of correctness of the responses. Therefore, selecting the survey participants aimed to find subsets of trustable participants whose data can best satisfy the quality-of-information (QoI) requirements. Thus, the survey was carried out amongst senior site managers, senior management team, surveyors or commercial team members, design and technical managers, client representatives or project managers, consultants, and project planners. For the client-related survey, 22 responded from a sample size of 25 participants. For the consultant-related survey, 28 responded from a sample size of 30 participants; for the contractor-related survey, 53 responded from a sample size of 55 participants; and for the external-related survey, 11 responded from a sample size of 15 participants.

The data received from the respondents were processed in MS Excel and analysed in SPSS to generate statistical frequencies. Furthermore, The Relative Importance Index (RII) (Kometa, Olomolaiye and Harris, 1994) was used to determine the relative significance and ranking of the probability and impact of the delay factors before a risk rating analysis and ranking were finally performed. The risk analysis and ranking results were assigned a new code; only the top ten risks in each of the four analysed risk categories are presented.

RESULTS OF ANALYSIS

The survey participants have a high level of experience and credibility in responding to the survey questions. In the client-related factors group, 86.3% of the participants have above 10 years of experience; a higher percentage, 90%, of the participants in the consultant-related factors group have more than 10 years of experience. Similarly, 81.1% of the participants in the contractor-related group have more than 10 years of experience in the construction industry. But the external-related group shows that 54.6% of the participants have more than 10 years of experience in the construction industry. The average years of experience for the participants with more than 10 years of experience for the four groups is 78%. These percentages will rise significantly if the participants with 6-10 years of experience are considered.

Table 2 shows the results for the client-related delay factors category. The overall RII analysis shows that (Delay in decision-making and order issuance by the client) and (Variation and changes in design) are the most risk factors effects in construction projects with RIIs= 0.542. These are followed by (Delay in revising and approving design documents by owner) with RII= 0.535, and the fourth risk factor is (Variation orders/changes of scope by owner during construction), which has RII= 0.528, and the (Unrealistic contract or project cost) is the fifth risk factor with RII= 0.516.

TABLE 2: RII for the client-related delay factors

Code	Client Factors	Probability		Impact		Overall Risk	
		RII	Rank	RII	Rank	RII	Rank

TCL1	Delay in decision-making and order issuance by the client	0.736	2	0.736	4	0.542	1
TCL2	Variation and changes in design	0.718	3	0.755	2	0.542	1
TCL3	Delay in revising and approving design documents by owner	0.745	1	0.718	8	0.535	3
TCL4	Variation orders/changes of scope by owner during construction	0.700	5	0.755	2	0.528	4
TCL5	Unrealistic contract or project cost	0.709	4	0.727	6	0.516	5
TCL6	Work stoppages	0.673	8	0.764	1	0.514	6
TCL7	Delayed approval of submittals	0.691	6	0.700	10	0.484	7
TCL8	Poor coordination, communication, and conflict between different parties	0.655	9	0.727	6	0.476	8
TCL9	Unrealistic contract duration imposed by owner	0.655	9	0.700	10	0.458	9
TCL10	Inaccurate or poorly defined scope and inadequate understanding of clients' needs	0.645	12	0.709	9	0.458	10
N (number of participants) = 22							

Table 3 shows the results for the consultant-related delay factors category. The overall RII analysis shows the (Delay in approval of drawings) with RII= 0.525 as the highest delay risk, followed by (Delay in design preparation and late revision of designs) with RII= 0.518. The third delay risk is (Frequent design changes, mistakes or changes in the design criteria provided by the employer) with RII= 0.510, the fourth delay risk is (Slow response by the consultant to contractor's enquiries) with RII= 0.497, and (Poor design with constructability problems) ranked the fifth delay risk with RII= 0.496.

TABLE 3: RII for the consultant-related delay factors

Code	**Consultants Factors**	**Probability**		**Impact**		**Overall Risk**	
		RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**
TCO1	Delay in approval of drawings	0.750	1	0.700	8	0.525	1
TCO2	Delay in design preparation and late revision of designs	0.740	2	0.700	8	0.518	2
TCO3	Frequent design changes, mistakes or changes in the design criteria provided by the employer	0.680	6	0.750	1	0.510	3
TCO4	Slow response by the consultant to contractor's enquiries.	0.690	3	0.720	5	0.497	4

TCO5	Poor design with constructability problems	0.670	7	0.740	2	0.496	5
TCO6	Errors or mistakes in design documentation and design errors and omissions made by designers	0.690	3	0.700	8	0.483	6
TCO7	Incompetent or inadequate experience of design team	0.650	11	0.740	2	0.481	7
TCO8	Unclear and inadequate details and specification	0.660	8	0.720	5	0.475	8
TCO9	Delay in providing design information to the main contractor	0.660	8	0.700	8	0.462	9
TCO10	Poor communication, coordination, and internal conflicts in the consultant office	0.650	11	0.710	7	0.462	10
N (number of participants) = 28							

Table 4 shows the results for the contractor-related factors category. The (Delay in providing utilities) ranked 1st in the RII for both the probability and impact assessment. Hence the factor ranked highest in the risk factor with RII= 0.578. The second risk factor identified is (Construction mistakes, defective works, and rework) with RII= 0.550 and ranked 2nd and 4th in the probability and impact assessment, respectively. Closely followed in third place is (Delay in subcontractor works) with RII= 0.547. the fourth and fifth delay risk factors are (Delay in supply of construction materials and material shortage) and (Unrealistic contract duration or inaccurate estimation of project duration) respectively, with their respective RII= 0.538 and RII= 0.513.

TABLE 4: RII for the contractor-related delay factors

Code	Contractor Related Factors	Probability		Impact		Overall Risk	
		RII	Rank	RII	Rank	RII	Rank
TCN1	Delay in providing utilities	0.751	1	0.770	1	0.578	1
TCN2	Construction mistakes, defective works, and rework	0.740	2	0.743	4	0.550	2
TCN3	Delay in subcontractor works	0.740	2	0.740	5	0.547	3
TCN4	Delay in supply of construction materials and material shortage	0.713	4	0.755	2	0.538	4
TCN5	Unrealistic contract duration or inaccurate estimation of project duration	0.687	7	0.747	3	0.513	5
TCN6	Incompetent or inexperienced subcontractors	0.687	7	0.736	7	0.505	6
TCN7	Underestimation of project complexity	0.687	7	0.736	7	0.505	6

TCN8	Inadequate experience by the main contractor, poor site management, supervision, and control over project	0.683	10	0.732	9	0.500	8
TCN9	Changes in material types during construction	0.706	5	0.706	13	0.498	9
TCN10	Delay in getting licenses and approvals from the government by the main contractor	0.672	11	0.740	5	0.497	10
N (number of participants) = 53							

Table 5 shows the results for the external-related factors category. The (Adverse weather condition) is ranked 1st with RII= 0.465, followed by (Delays or issues regarding permissions and statutory approvals) with RII= 0.463. The third-rated risk is (Changes in material types and specifications) with RII= 0.451, followed in the fourth rank by (Shortage of quality materials in the market and shortage of suppliers). The fifth-ranked delay risk is (Poor or unforeseen site conditions (location, ground, topography, etc.) with RII= 0.417.

TABLE 5: RII for the external-related delay factors

Code	External Factors	Probability		Impact		Overall Risk	
		RII	Rank	RII	Rank	RII	Rank
TEX1	Adverse weather condition	0.691	3	0.673	3	0.465	1
TEX2	Delays or issues regarding permissions and statutory approvals	0.727	1	0.636	7	0.463	2
TEX3	Changes in material types and specifications	0.709	2	0.636	7	0.451	3
TEX4	Shortage of quality materials in the market and shortage of suppliers	0.636	4	0.691	1	0.440	4
TEX5	Poor or unforeseen site conditions (location, ground, topography, etc.)	0.636	4	0.655	6	0.417	5
TEX6	Transportation delay in delivery of materials and plant items	0.636	4	0.636	7	0.405	6
TEX7	Poor economic conditions, Inflation – increase in the price of materials and labour	0.600	7	0.673	3	0.404	7
TEX8	Difficulties in obtaining equipment and tools on the market	0.564	10	0.673	3	0.379	8
TEX9	External work due to public agencies	0.564	10	0.636	7	0.359	9
TEX10	Mistakes and discrepancies in contract documents	0.600	7	0.582	14	0.349	10
N (number of participants) = 11							

DISCUSSION OF RESULT

From the result presented for the client-related factors, the client's delay in decision-making was flagged as the most ranking risk. The project stakeholders cannot progress crucial activities if the client is not proactive in decision-making. This result is consistent with what was reported by Kassem, Khoiry, and Hamzah, 2020; Umar, Rizeiqi, and Badr, 2020; and Hoque *et al*., 2021, who also found this delay factor as one of the top delays in this category. Also, when the client instructs variation and changes in design, the time taken to carry out the required design changes and procure relevant materials could impact the project's time baseline. Furthermore, revising the design and approving design documents by the owner requires crucial gateways for the client to review, comment and approve the drawings and documents. This process takes time and could drag on when it is not adequately coordinated, resulting in delays. Also, clients may be compelled to instruct variation orders or change the project's scope during construction due to regulatory requirements or to improve the project's viability, among other important reasons. When this happens, the project team is often required to assess the impact of the changes on the cost and time baselines. Work stoppages and delays often arise because of these instructions and assessments.

In the consultant-related factors category, the delays in the approval of drawings by the consultants and the delay in the design preparation, including the late revision of designs, were deemed top-ranking risks. These delays impact the commencement of subcontractor and material procurement activities which would directly delay the start on site of trades. Particularly, when the design affected includes designs relating to the subcontractor design packages, the delays could directly impact the release of the final construction drawings, resulting in delays to the works on site of these crucial packages. Therefore, when there are frequent design changes, mistakes or changes in the design criteria provided by the employer, the impact could be very significant, driving substantial delays to the project.

The delay in providing utilities ranked first in the result for the contractor-related factors category. In the UK, the procurement of utility companies is often on a long lead-in. Hence, this risk factor appears to contribute significantly to project delays when it is not adequately planned and managed. In the second rank is construction mistakes, defective works, and rework, which are compatible with but varied in ranking from studies by Famiyeh *et al*. (2017), Gebrehiwet and Luo (2017), Habibi and Kermanshachi (2018), Hasan and Mohammed (2018), Kassem, Khoiry, and Hamzah (2020), and Hoque *et al*. (2021). Poor quality delivery and rework do not only increase the overall project cost; the correction of defects often puts construction work out of the correct sequence and prolongate the overall project time. Furthermore, the delay in subcontractor works emphasises the challenge contractors face when subcontractors' productivity is below planned requirements. Similarly, the delay in the supply of construction materials and shortage of materials could drive similar delays in a project. In the UK, the effect of BREXIT means longer material procurement lead-in and more on-site storage challenges. Optimism bias (ROMEO, 2017) often drives unrealistic contract duration or inaccurate project duration estimation. Hence, the baseline requirements established from the project's outset are often misleading or wrong.

From the result for the external-related factors category, adverse weather conditions, especially during winter, appear to be a considerable challenge and a significant risk driving project delay in the UK. The installation of specific trades' activities like screed, brickwork, wet plaster, and flooring must be carried out under the right atmospheric temperature; peak winter temperature does inhibit this. The other top-ranking delay risks identified include government bureaucracy and delays or issues regarding permissions and statutory approvals. This delay occurs particularly when material or non-material amendments to approved planning permission are required. These amendments are often needed when there are changes in material types and specifications which are often driven by the need to comply with changes in building regulations (Approved Documents, 2022). Also, BREXIT and the COVID-19 pandemic have impacted the demand and supply of material across Europe. Hence, the market's shortage of quality materials and suppliers has become a significant risk to construction projects. Finally, one of the significant risks that impact the early stages of projects arises when poor or unforeseen site conditions are encountered during the groundworks. This risk could put a project in delay very early on, and the uncertainty could persist through to the completion of the project.

These results are partially compatible with other studies with some difference in the ranking of the delay or risk factors. The literature review and the results suggest that the region where similar research is carried out influences the outcome as there would be peculiar micro and macro factors driving project delays that are peculiar to these different regions. For instance, whilst adverse weather conditions ranked 1st in this study in the external-related factors category, other studies from other countries suggest it is ranked lower. Similarly, in Ghana, the delay in decision-making by the clients was ranked 9th in the study by Famiyeh *et al*. (2017). However, results from the client-related factor category show that the risk of this factor ranked 1st, ranked 2nd in the probability of occurrence and 4th in the impact rating. From the preceding, it can also be deducted that a general ranking of these factors does not truly reflect their risk importance. The risk-rating approach adopted in this study balances the significance between the probability of their occurrence and their impact or severity.

CONCLUSION

This research contributes to the growing literature on projects' time overruns by identifying top-ranking risks in four categories of delay factors – clients, consultants, contractors and external related factors. From the results across these four categories, some top-ranking risks identified include delay in decision-making and order issuance by the client, delay in the approval of drawings, delay in providing utilities, and adverse weather conditions. From the risk rating results, the project leads or senior management team can arrange the appropriate strategies and responses to plan for and mitigate project risks to influence the success of projects in the UK. The outcome of this study can equally be used as a guide for delays risk planning and mitigation in other countries.

Due to the many factors studied, each delay factor category is surveyed and analysed independently. Hence, it is difficult to compare the risk rating of the factors in the four categories as there would be no significant correlation between them. However, as part of ongoing research, the results have helped to identify the top risks from the many delay factors studied. From the leading risk factors identified in this study, further surveys and analyses could be conducted where the same participants would contribute to all the top factors identified in the four categories to help generate correlations or relationships in the risk ranking of the delay factors.

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