Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

FACTORS AFFECTING OPERATION AND MAINTENANCE COST BUDGET IN HIGHWAY PROJECTS

Monirul Islam[1]
Sarajul Fikri Mohamed[2]
Syamsul Hendra Mahmud[3]

[1]Faculty of Built Environment and Surveying, UTM, Johor Bahru, Malaysia, (Email: monir176@gmail.com)
[2]Faculty of Built Environment and Surveying, UTM, Johor Bahru, Malaysia, (Email: sarajul@utm.my)
[3]Faculty of Built Environment and Surveying, UTM, Johor Bahru, Malaysia, (Email: b-samsul@utm.my)

Article history

Received date	**:**	15-12-2021
Revised date	**:**	13-1-2022
Accepted date	**:**	25-2-2022
Published date	**:**	31-3-2022

To cite this document:
Islam, M., Mohamed, S. F., & Mahmud, S. H. (2022). Factors Affecting Operation and Maintenance Cost Budget in Highway Projects. *International Journal of Accounting, Finance and Business (IJAFB)*, 7(39), 125 - 143.

Abstract: *Road maintenance are complex systems, and therefore truly understanding their budget is difficult. The high cost of operation and maintenance is a real problem and a major issue in highway projects, and it constitutes a significant part of the total life cycle cost. This study intends to examine the factors attributed to increased operation and maintenance cost and the highway components' difficulty level of operating and maintaining. A literature analysis identified 22 factors responsible for increasing operation and maintenance costs and 23 highway components that are hard to operate and maintain at the post-construction phase. That analysis was followed by a questionnaire survey, and 70 respondents graded the identified factors using a five-point Likert scale during an online survey. The mean and relative importance index (RII) of the factors and highway components were determined, followed by rank analysis. This study demonstrates that poor road design, lack of maintenance plan, high maintenance cost due to lower maintenance quality, poor construction quality, and risk of corruption significantly affect the operation and maintenance cost budget. Among highway components, pavement markings, above the ground bridge (road bridge, pedestrian/ motorcycle bridge), electrical devices, traffic calming devices, traffic and above ground services were rated as the most difficult to operate and maintain. Finally, the relationships between the factors affecting operation and maintenance cost and the highway components were identified using correlation tests. This study provides insight into the major factors of operation and maintenance cost budget and difficulty level of highway components for maintenance.*

Keywords: *Factors, Operation and Maintenance, Budget, Cost, Highway Projects*

Introduction

The construction industry contributes significantly to the economy and development of the country, as it provides many employment opportunities and essential infrastructure. Successful completion of construction projects is the prime prerequisite for the thriving construction industry. Compliance with standard requirements was seen as an important requirement for effective construction projects. The higher maintenance quality of a construction project is the

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

fulfillment of customer requirements and end-user satisfaction (Ameyaw & Chan, 2015; de França & Coelho, 2015). Quality is considered vital for modern organizations, since it improves profitability and efficiency, reduces costs and guarantees long-term collaboration with customers (Ljevo et al., 2018). However, lower maintenance quality is a common issue in the construction industry (Al Nahyan Moza et al., 2019; Burke & Demirag, 2015; Chung et al., 2010; Sousselier et al., 2015). The highway project is regarded as of poor construction quality if it fails to achieve its goals and the needs of the owner are not met (Ali & Wen, 2011; Mallawaarachchi & Senaratne, 2015; Oladimeji & Aina, 2018). Lower maintenance quality has many negative effects on the construction industry such as conflicts between parties involved in construction projects, increased operation and maintenance costs, loss of productivity, and poor reputation (Oladimeji & Aina, 2018). Reviewing the literature shows high maintenance cost due to lower maintenance quality is a global phenomenon in highway projects. Construction Industry Institute, US(CII), conducted a study to define and measure the additional costs due to lower maintenance quality in construction projects (Hussain et al., 2018; Karimi et al., 2017). It was found that poor construction quality can add 25% extra to the final project cost. Further, (Hussain et al., 2018) stated that a study conducted by Building Research Establishment, UK (BRE) concluded that construction projects built with poor construction quality require excessive maintenance and repair, which can cause an additional cost. According to Koch and Schultz (2019), due to the rapid increase in population in Hong Kong, the Government is concerned about quantity than quality maintenance of construction projects. Which resulted in the lower maintenance quality of construction projects requiring repair works. It is stated by (Ajao et al., 2018) that defects are persistent in the construction project of Ghana due to deviation from good maintenance standards. (Akmam Syed Zakaria et al., 2018) stated that certain construction projects in Malaysia fail to achieve the client's satisfaction on the quality maintenance level. It is quoted by (Lee, 2019) that according to the reports of the World Bank, only 20% of road projects in Asian countries are at the desired level of good maintenance. Likewise, in other countries, the construction industry in Malaysia is also recognized by lower maintenance quality. A study carried out by (Khan et al., 2019) confirmed that the construction industry of developing countries is struggling for achieving quality maintenance for a long time. Moreover, (Kamble & Sanadi, 2019) and (Naji et al., 2018) also stated that construction projects in Malaysia are facing the issue of poor construction quality. Bangladesh's highway network is comprised of 144,403 kilometers and it carries 80 % of the country's freight and passenger traffic, making it one of the significant sectors shearing to GDP. In the overall transport sector shear 10% to Country GDP and employing 2 million people. However, highway projects in Bangladesh also fail to achieve the desired quality maintenance standards (Goh et al., 2017; Lop et al., 2017). In previous various studies have been carried out on the quality maintenance of construction projects in different countries. However, there is a still need to explore the factors of maintenance in Highway projects of Bangladesh. Hence, the aim of this study is to determine and evaluate factors affecting operation and maintenance cost budget in highway projects.

Literature Review

Literature reviews show that numerous works has been carried out to analyze factors that affect the efficiency of construction projects. (Shobana & Ambika, 2016) identified that factors affect the operation and maintenance cost budget of construction projects in India were poor coordination among workers, labour shortage, late supply of materials, labours work more than 8 hours per day, lack of proper inspection, lack of skilled labour, financial problems arise during construction, and changes in design. A survey was carried out by (Oke et al., 2017) to highlight the factors affecting operation and maintenance cost budget in construction projects in

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Swaziland. The results of the survey showed that the main factors affecting operation and maintenance cost budget in construction projects were unexperienced subcontractors, poor supervision on site, unskilled labours, poor planning, lack of communication, project manager's ignorance, poor material management, poor plant management, and design changes. (Enshassi et al., 2009) quoted that according to construction stakeholders handling a large number of projects at the same time, material shortage, and unavailability of competent staff the operation and maintenance cost budget of construction projects. A questionnaire survey was conducted by (Jha & Iyer, 2006) to identify the factors affecting operation and maintenance cost budget of construction projects. Analysis of the survey showed that factors affecting operation and maintenance cost budget in construction projects are: conflicts among parties involved in the project, harsh weather conditions, lack of knowledge with the project manager, and unfair award of contract. The main factors affecting operation and maintenance cost budget in the Malaysian construction industry are lack of quality awareness in project participants, lack of support from the top management, improper planning, and unskilled workers (Sohu et al., 2018). (Oyedele et al., 2015) investigated factors affecting operation and maintenance cost budget of construction projects in Nigeria by conducting a questionnaire survey in construction professionals. The results of the survey presented that significant factors affecting operation and maintenance cost budget are: poor quality of construction materials, low skill workers, lack of quality assurance, poor technical knowledge of contractors, unrealistic project cost, making slow decisions, and inadequate site supervision. Other factors affecting operation and maintenance cost budget of construction projects include unclear client's requirements for design, improper material selection, lack of coordination between designer and owners, use of improper equipment (Ahmed & Yusuff, 2016).

Methodology

The research design for this study is a quantitative approach because this is the most practical instrument in data collection (Au-Yong et al., 2014). In this study, a field survey was carried out, and based on factors identified through the literature review, a questionnaire was developed and distributed to 156 respondents categorized by their professional roles like government officials, contractor, consultants, supplier, Client/developer, located their working organization were Chittagong, Dhaka, Barisal, Khulna, Rajshahi and Mymensingh division in Bangladesh. This study adopted a sampling technique known as judgemental sampling, which is viable in obtaining data from a very specific group of people (Fellows & Liu, 2015). The weakness of this sampling process is biased data absent of randomization when obtaining the data. However, (Neuman, 2006) suggested that the best way to avoid this error is to choose the most reliable professional or authority. Therefore, this study focused on both criteria for the data collection. Through these alliances, it was expected that consensus among the respondents would ensure reliable and high quality information for this study. Finally, a total of 156 questionnaires were administered to participants through email and an online survey link. This was intended to achieve a sufficient response rate. According to (Roscoe, 1975) cited by (Yap Jeffrey Boon et al., 2017), the acceptable range of sample size (f) is $30 \leq f \leq 500$ for most research. The overall research design of this study is illustrated in Fig. 2. It depicts the way this study was undertaken according to four phases. The finalized questionnaire contained three sections. The first section is intended to gather general information on the respondents. This includes their role in projects, gender, age, highest academic qualification, year of experience in highway projects and location of the project involved. The second part involves the rating of the 22 factors of increasing operation and maintenance cost. A five-point Likert scale where 1 = no impact, 2 = minor impact, 3 = neutral, 4 = moderate impact, and 5 = major impact was adopted to measure the importance of each factor and 1 = very easy, 2 = easy, 3 = neutral, 4 = difficult, and 5 = very

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

difficult was adopted to measure the difficulty level of highway components. This technique has also been applied to numerous construction management research (Hwang & Yang, 2014; Ye et al., 2015). The last part involves rating the difficulty level of 23 highway components to operate and maintain using the similar five-point Likert scale. The numerical score of each factor and highway components were transformed to measure relative importance index (RII) in order to assess the ranking, using the following formula [Eq. (1)]:

$$\textbf{Relative importance index (RII)} = \frac{\sum_{i=n}^{n} W_i}{N \times W_H} \quad (1)$$

Where $0 \leq \text{RII} \leq 1$; W_i = score of each factor as rated by the respondents, ranging from 1 to 5 (1 is the least and 5 is the most important) in the survey; N = total number of respondents; and WH = highest score (i.e., 5) adopted in the survey. All data obtained from this study were analyzed using the Statistical Package for Social Science (SPSS) Version 25 to get the mean and standard deviation (SD). This analysis was conducted using percentages in order to determine the frequency of each category in question. Foremost, a reliability analysis was performed to ensure consistency and stability of the collected data (Leech et al., 2014). Statistical tests such as correlation tests were conducted utilizing SPSS. Spearman's rank correlation analysis was performed to explore the possible significant relationships between factors affecting operation and maintenance cost and the most difficult highway components. Fig. 2 presents the theoretical framework for factors affecting operation and maintenance cost budget.

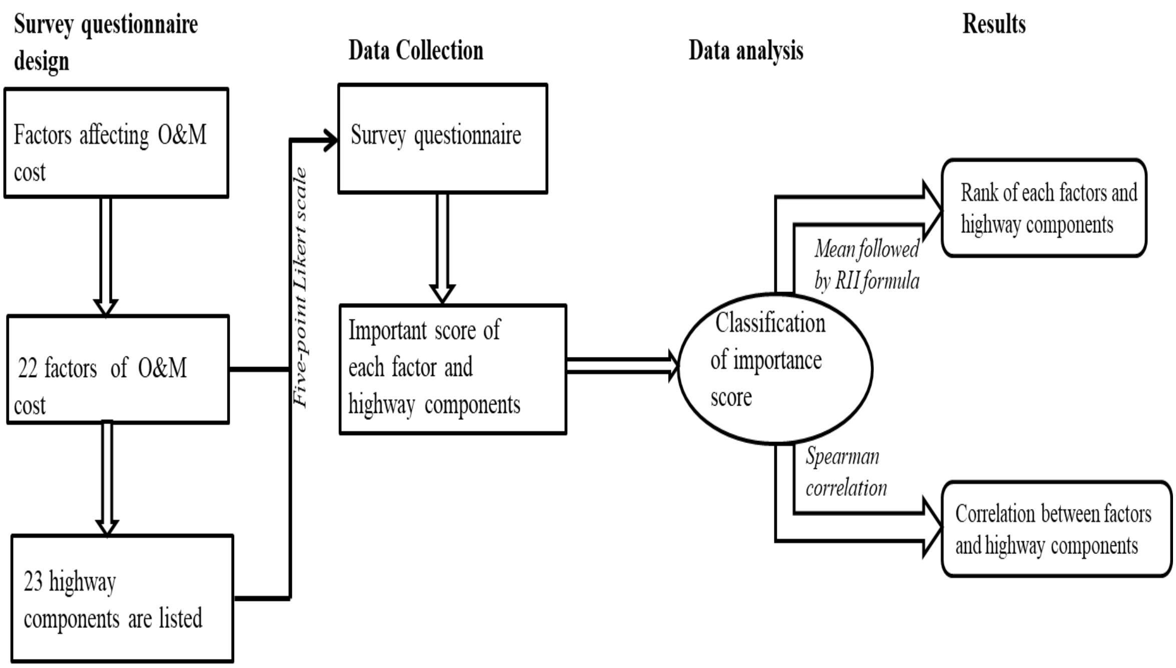

Figure 1: Research design

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

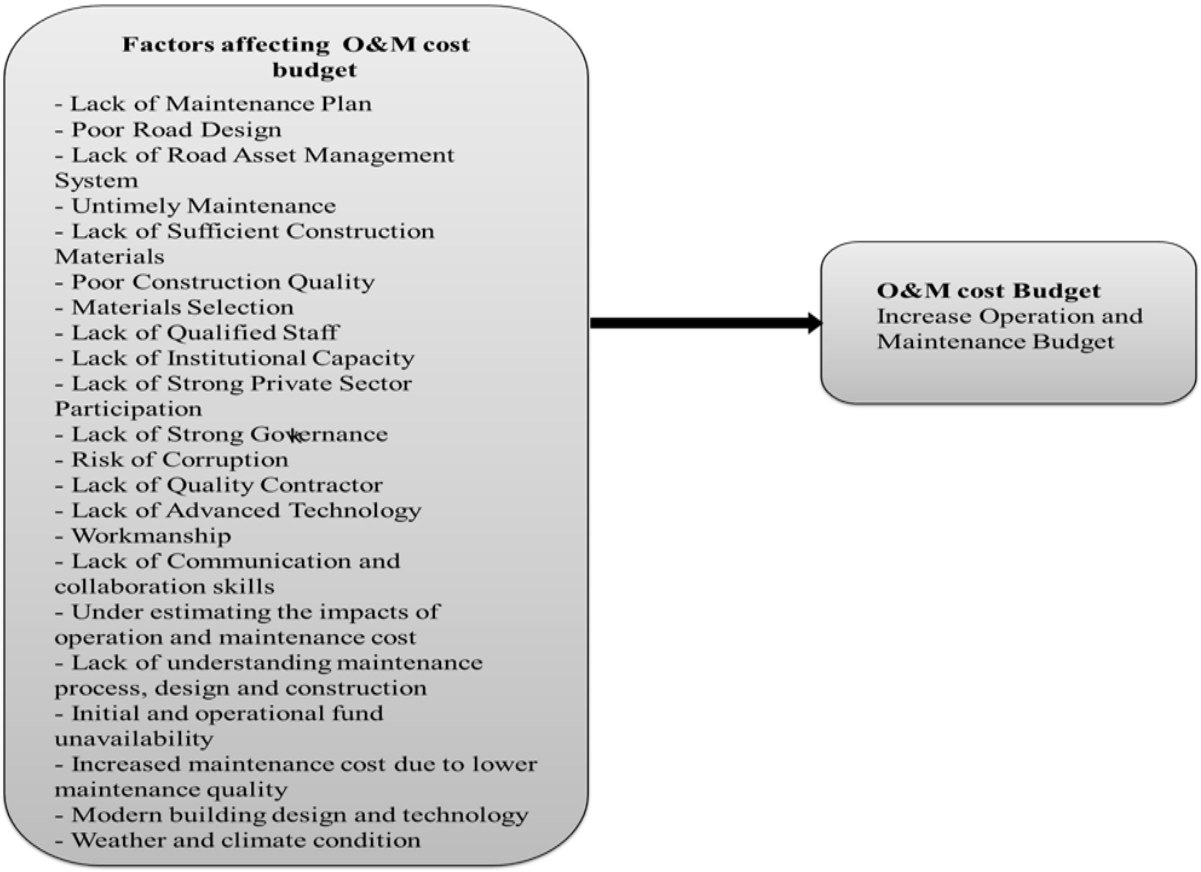

Figure 2: Factors affecting O&M cost budget

Data Analysis

Sample Characteristics

At the end of the survey period, a total of 70 responses were received, providing a response rate of 44.9%. (Tan et al., 2014) stated a response rate of 10%–20% is acceptable in a research survey. Overall, 70 replies fulfilled the requirements for a valid response: all questions were fully answered and there were no vague answers (i.e., given the same score for each question). Table 1 presents detailed information about the respondents' demographic background. Although all the survey respondents had a background in the organization named Local Government Engineering Department of Bangladesh, their roles in the organization were diverse. More than two-thirds (77.14%) of the respondents had the role of government officials, and others was followed by contractor (10%), consultants (8.57%), supplier (2.86%). Client/developer (1.43%). The gender status of the respondents are as shown in Table 1. The majority of the respondents were male, representing 95.71% of the total respondent in this research. Figure 4.2 shows the number of male respondents are 95.71% and female respondents lower with 4.29%. Table 1 shows that the majority of the respondents are in between 30 to 39 years old with 51 respondents. Meanwhile, finding shows 20% for 20 to 29 years old and 40 to 49 years old with both 4 respondents for each range. The finding also shows only one respondent who reach the age of 50 years old and above. The level of academic achievement is the only technique in an online survey to measure the respondents' capability, skill, and level of knowledge. This study found the highest level of academic achievement of respondents was master's degree (67.14%), followed by bachelor's degree (28.57%). For the rest of the respondents, the highest level of academic achievement was Diploma (1.4%) and Doctorate

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

(2.9%), Other (1.4%) as shown in Table 1. The respondents' work experience in the highway projects is also another index to measure their level of knowledge and hence the reliability of the data. Information regarding their experience shows (Table 1) that 67.14% of the respondents had 5-10 years 'experience in highway projects. Meanwhile, the second groups of major respondents consist of less than 5 years of experiences is 18.57%. Table 1 show the composition of the location of the respondent 's working organization location which had answered the questionnaires. From the data obtained shows that the majority of the respondents were from Chittagong and Dhaka division which representing 30% and 28.57% respectively. While Barisal, Khulna, Rajshahi and Mymensingh division had the different number of respondents which is 14.28%, 12.86%, 9% and 4.29%. The least of respondents were from Sylhet with only 1.43%.

Table 1: Demographic information of respondents

Characteristics	Categorization	Response Count (N=70)	Response Percentage
Role in projects	Client/Developer	1	1.43
	Consultants	6	8.57
	Contractor	7	10
	Government Officials	54	77.14
	Supplier	2	2.86
Gender	Male	67	95.71
	Female	3	4.29
Age	20-29 years	14	20
	30-39 years	51	72.86
	40-49 years	4	5.71
	>50 years	1	1.43
Year of experience in Highway Projects	<5 years	13	18.57
	5-10 years	47	67.14
	11-15 years	8	11.43
	16-20 years	0	0
	>20 years	2	2.86
Academic qualification	Diploma or below	1	1.43
	Bachelor Degree	20	28.57
	Master Degree	47	67.14
	Doctoral Degree	1	1.43
	Other	1	1.43
Location of projects	Dhaka Division	20	28.57
	Mymensingh Division	3	4.29
	Chittagong Division	21	30
	Rangpur Division	0	0
	Rajshahi Division	6	8.57
	Khulna Division	9	12.86
	Barisal Division	10	14.28
	Sylhet Division	1	1.43

Table 2: Reliability analysis using Cronbach's alpha items

Category	Cronbach's Alpha	Number of Items
Factors affecting O&M cost	0.976	22
Road Surface Components	0.783	4
Slope and Retaining Structure Components	0.863	4
Drainage Components	0.881	4
Bridges and other structure Components	0.956	2
Traffic/Road Furniture Components	0.968	9

The participation of highly experienced and educated respondents ensured that the survey had a good coverage of the highway projects and thus could yield highly credible and quality results. Ideally, future research should be conducted to minimize this concern and confirm the study result. According to (Sohu et al., 2018) in most developed countries 60 per cent of the total construction budget was spent on operation and maintenance. (Yap Jeffrey Boon et al., 2017) notes that the operation and maintenance costs constitute 55 per cent of the total expense over a period of forty years. As the then (Hassanain Mohammad et al., 2013) claimed, 75% of the toll collected by concession firms went to debt servicing whereas 20% was spent on maintenance and overheads. Poor budgetary management, incompatible management and poor road design are major three factors for increasing operation and maintenance cost. Funding issues are also the biggest problem in many countries, such as Bangladesh, India, Pakistan and Srilanka. A study by (Pan & Thomas, 2015) shows that due to untimely maintenance, maintenance costs can be increased by 14.20 per cent. (de Silva et al., 2004) also found that maintenance costs are 83% or 4-5 times higher than construction cost.

Reliability Analysis

Several types of research indicated that a value of Cronbach's alpha (α) acceptable for all studies ranges between $0.71 \leq \alpha \leq 0.99$ (Kamaruzzaman Syahrul et al., 2018; Pallant & Manual, 2010). The alpha (α) value was calculated as illustrated in Table 2 to test the internal consistency of the scale. In this study, the α value for affecting factors of operation and maintenance cost was 0.976, that for road surface components was 0.783, that for slope and retaining structure components was 0.863, drainage components was 0.881, bridges and other structural components was 0.956 and that for traffic/road furniture components was 0.968, which showed the strong internal consistency of the scale used and suggested reliable data have been obtained.

Factors Affecting Operation and Maintenance Cost

This section describes the factors that are responsible for increasing operation and maintenance costs. The findings as summarized in Table 3 indicate that respondents were more concerned about factors increasing the maintenance cost. According to (El-Haram Mohamed & Horner Malcolm, 2002), high operation and maintenance costs have become a common issue in the construction industry. The mean and SD for each factor were calculated followed by ranked order analysis using RII value. When two or more factors have the same RII value, the SD values are compared, and the lower SD is considered the higher rank. If the RII value and SD are both the same, they were assigned to the same rank (Tan et al., 2014) . As indicated in Table 3, the respondents ranked poor road design (mean 4.89) as the most significant issue to increase the O&M cost. Poor road design are often caused by human error or oversight on the part of the designers. Improper decisions taken at the design stage will yield lower construction quality and inevitably call for early maintenance during the lifespan of the highway. Therefore, there is a need to consider maintenance at the design part of highway projects in order to prevent

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

unplanned maintenance. Design faults are expensive mistakes in terms of occupants 'life and a large number of maintenance expenditures can be reduced through reducing poor road design (Gatlin, 2013). Moreover, (Yap Jeffrey Boon et al., 2017) concluded that cost-effectiveness can be value-added in highway projects through minimizing poor road design reoccurrence rate. The importance indices for all issues are illustrated in Table 3, clearly indicate that poor road design is ranked as the most important. It can be seen from the data in Table 3 that lack of maintenance plan‖ (mean = 4.87) was highlighted by the respondents as the second most influential issue to increase the operation and maintenance cost. In accordance with the present result, previous studies have demonstrated that lack of maintenance management plan is attributed to high maintenance budget in Malaysia (Kamaruzzaman Syahrul et al., 2018). In addition, (Mirdeeliana, 2012) revealed that the key reason for the higher cost of maintenance is considered as a result of lack of maintenance. The importance indices for all issues are illustrated in Table 3, which clearly indicates that poor road design are ranked as the most important factor by all respondents with a value of 0.977. It can be seen from the data in Table 3 that lack of a maintenance plan (mean 4.87, RII 0.974) was highlighted by respondents as the second most influential issue to increase the operation and maintenance cost.

Table 3: O&M cost increasing factors

Serial	Factor	Mean	SD	N	RII	Rank
1	Lack of Maintenance Plan	4.87	0.50	70	**0.974**	**2**
2	Poor Road Design	4.89	0.47		**0.977**	**1**
3	Lack of Road Asset Management System	4.14	0.52	70	0.829	14
4	Untimely Maintenance	3.64	0.89	70	0.729	18
5	Lack of Sufficient Construction Materials	3.71	0.95	70	0.743	15
6	Poor Construction Quality	4.29	0.57	70	**0.857**	**4**
7	Materials Selection	4.14	0.49	70	0.829	13
8	Lack of Qualified Staff	4.21	0.54	70	0.843	8
9	Lack of Institutional Capacity	3.67	0.94	70	0.734	16
10	Lack of Strong Private Sector Participation	3.59	0.94	70	0.717	22
11	Lack of Strong Governance	4.19	0.62	70	0.837	10
12	Risk of Corruption	4.26	0.65	70	**0.851**	**5**
13	Lack of Quality Contractor	3.66	0.93	70	0.731	17
14	Lack of Advanced Technology	3.63	0.90	70	0.726	20
15	Workmanship	4.20	0.69	70	0.840	9
16	Lack of Communication and collaboration skills	3.63	0.89	70	0.726	19
17	Under estimating the impacts of operation and maintenance cost	4.16	0.61	70	0.831	12
18	Lack of understanding maintenance process, design and construction	4.17	0.58	70	0.834	11
19	Initial and operational fund unavailability	4.24	0.65	70	0.846	6
20	high maintenance cost due to lower maintenance quality	4.30	0.64	70	**0.860**	**3**
21	Modern highway construction and technology	3.63	0.93	70	0.726	21
22	Weather and Climate Condition	4.24	0.71	70	0.849	7

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Furthermore, Table 3 indicates that high maintenance cost due to lower maintenance quality (mean 4.30, RII 0.860) is also rated as an important factor in this cluster by respondents. Additionally, respondents also emphasized poor construction quality (mean 4.29, RII 0.857), risk of corruption (mean 4.26, RII 0.851), initial and operational fund unavailability (mean
Furthermore, Table 3 indicates that high maintenance cost due to lower maintenance quality (mean 4.30, RII 0.860) is also rated as an important factor in this cluster by respondents. Additionally, respondents also emphasized poor construction quality (mean 4.29, RII 0.857), risk of corruption (mean 4.26, RII 0.851), initial and operational fund unavailability (mean 4.24, RII 0.846), weather and climate condition (mean 4.24, RII 0.849) , lack of qualified staff (mean 4.21, RII 0.843), workmanship(mean 4.20, RII 0.840), lack of strong governance(mean 4.19, RII 0.837), lack of understanding maintenance process, design and construction(mean 4.17, RII 0.834), under estimating the impacts of operation and maintenance cost as other significant factors(mean 4.16, RII 0.831), materials selection(mean 4.14, RII 0.829), lack of road asset management system(mean 4.14, RII 0.829), lack of sufficient construction materials(mean 3.71, RII 0.743), lack of institutional capacity(mean 3.67, RII 0.734), lack of quality contractor (mean 3.66, RII 0.731), untimely maintenance(mean 3.64, RII 0.729), lack of communication and collaboration skills(mean 3.63, RII 0.726), lack of advanced technology(mean 3.63, RII 0.726), modern highway construction and technology (mean 3.63, RII 0.726), lack of strong private sector participation (mean 3.59, RII 0.717) as other significant factors, as indicated in Table 3. Interestingly, the result of the survey shows that untimely maintenance is one of the least important factors (18th) with an RII of 0.729 (Table 3). This value is not very different from other important factors as presented in Table 3; however, this study's adopted rank analysis based on RII value placed it bottom of the list. Thus, this factor is considered as a less significant factor in the Bangladesh's highway maintenance department. In contrast with the previous study, untimely maintenance appears to be an important factor that affects O&M cost in other countries, such as Saudi Arabia (Hassanain Mohammad et al., 2013) (ranked third), Nigeria (Waziri, 2016) (ranked fourth), and Hong Kong (Tam et al., 2017) (ranked first). Even the study on Malaysia by (Aris, 2006) recognized untimely maintenance as the most important factor. This leads to an assumption that the importance of factors is dependent on location, type, size, and complexity of the project (Kärnä & Junnonen, 2017). Further, they added respondents' characteristics, especially experience, knowledge, and cultural values. Thus, untimely maintenance may be a product of poor road design and has a great impact on increasing operation and maintenance costs. Presently, in Bangladesh, construction parties are emphasizing their focus on this issue and involve a quality control team during construction to ensure the best quality.

Correlation Test for Factors Affecting Operation and Maintenance Cost Budget

The Spearman's rank correlation analysis showed statistically significant correlations between five independent factors: poor road design, lack of maintenance plan, high maintenance cost due to lower maintenance quality, poor construction quality and risk of corruption with correlation coefficient values of 0.362, 0.588, 0.792, 0.823, and 0.927, respectively (Table 4). weather and climate condition, initial and operational fund unavailability, lack of qualified staff, workmanship, lack of strong governance, lack of understanding maintenance process, design and construction, and under estimating the impacts of operation and maintenance cost were also statistically less significant. Lack of strong private sector participate, lack of quality contractor, lack of advanced technology, modern highway construction and technology were not statistically significant.

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Table 4: Correlation Coefficient of O&M Cost

Serial	Factor	Spearman	Significance (two-tailed)
1	Lack of Maintenance Plan	**0.362[b]**	**0.002**
2	Poor Road Design	**0.588[a]**	**0**
3	Lack of Road Asset Management System	0.177	0.144
4	Untimely Maintenance	0.083	0.497
5	Lack of Sufficient Construction Materials	0.056	0.646
6	Poor Construction Quality	**0.792[a]**	**0**
7	Materials Selection	0.080	0.508
8	Lack of Qualified Staff	0.098	0.418
9	Lack of Institutional Capacity	0.015	0.903
10	Lack of Strong Private Sector Participate	-0.088	0.470
11	Lack of Strong Governance	0.089	0.465
12	Risk of Corruption	**0.823[a]**	**0**
13	Lack of Quality Contractor	-0.073	0.550
14	Lack of Advanced Technology	-0.040	0.745
15	Workmanship	0.271	0.023
16	Lack of Communication and collaboration skills	0.035	0.774
17	Under estimating the impacts of operation and maintenance cost	0.276	0.021
18	Lack of understanding maintenance process, design and construction	0.199	0.098
19	Initial and operational fund unavailability	0.104	0.392
20	High maintenance cost due to lower maintenance quality	**0.927[a]**	**0**
21	Modern highway construction and technology	-0.038	0.756
22	Weather and Climate Condition	0.106	0.382

Note: Bold values highlights the top most five RII values and ranking.
[a]Correlation is significant at 0.01 level (two-tailed).
[b]Correlation is significant at 0.05 level (two-tailed).

Difficulty Level to Maintain Highway Components

The analysis of the most difficult operation and maintenance of highway components were classified into five groups including road surface, slope and retaining structure, drainage, bridges and other structure, traffic/road furniture. Table 5 represents the maintenance difficulties of highway components in post-construction phase. The results show that, in Table 5, "median", "shoulder & verge" and "slope" were the most difficult elements in the road surface group as mentioned by the respondent. According to analysis in Table 5, the respondents reported that median is the most critical component to operate and maintain also have the highest value of the mean and important index. The factor of not considering "median" maintenance access was considered as the most severe defect by the respondent with a highest

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

relative importance index of 0.76 in the road surface group. In addition, respondents have indicated “shoulder & verge” related work as the second most difficult components in this group with the mean value 3.73. Furthermore, the respondents have also highlighted “slope” as a significant component in this group that is difficult to maintain and operate, with the calculated mean value 2.86 and an important index of 0.57 as illustrated in Table 5.

Table 5: Assessment of Highway Components

Serial	Highway Components	Mean	SD	RII	Rank In Group	Rank Overall
	Road Surface Components					
1	Carriageway	2.61	1.195	0.523	4	21
2	Shoulder & Verge	3.73	0.833	0.746	**2**	12
3	Median	3.79	0.759	0.757	**1**	9
4	Slope	2.86	1.094	0.571	3	20
	Slope and Retaining Structure Components					
5	Retaining Structure	3.49	1.164	0.697	3	15
6	Slope Drainage	2.39	1.067	0.477	4	23
7	Above Ground Services	3.83	0.900	0.766	**1**	6
8	Slope Furniture	3.76	0.955	0.751	**2**	11
	Drainage Components					
9	Drain	3.06	0.849	0.611	3	19
10	Drain Cover	3.73	0.815	0.746	**1**	13
11	Sump	3.21	0.778	0.643	**2**	16
12	Box Culvert/Pipe	2.50	1.073	0.500	4	22
	Bridges and other structure Components					
13	Above Ground Bridge (Road Bridge, Pedestrian/ Motorcycle Bridge)	4.21	1.361	0.843	**1**	**2**
14	Special Structures (Underpass/Vehicular Box Culverts, Tunnel)	3.57	1.269	0.714	2	14
	Traffic/Road FurnitureComponents					
15	Pavement Markings	4.53	0.944	0.906	**1**	**1**
16	Traffic	3.89	0.877	0.777	4	**5**
17	Traffic Calming Devices	3.94	0.832	0.789	3	**4**
18	Traffic Sign	3.81	0.997	0.763	5	7
19	Electrical Devices	3.99	0.752	0.797	**2**	**3**
20	Pedestrian Facilities	3.81	0.967	0.763	6	8
21	Kerbs	3.20	0.972	0.640	8	17
22	Traffic Barriers	3.76	0.999	0.751	7	10
23	Delineators	3.19	1.011	0.637	9	18

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

The important indices for all components are illustrated in Table 5, clearly shows that “median”, “shoulder & verge” and “slope’ are ranked as the most significant by all respondents, with an important index of 0.76, 0.75 and 0.57 respectively. This group comprises four major highway components as presented in Table 5. The analysis of the respondents’ perception of highway components data revealed that the most difficult slope and retaining structure components for maintaining, as shown in Table 5, were: “above ground services”, “slope furniture” and “retaining structure”. The respondents perceived that “above ground services” is the most difficult to operate and maintain with calculated high important index 0.766. The average result of all respondents represents that “slope furniture” was rated as the second most difficult components in this group, with a mean value and important index of 3.76 and 0.751 separately. Additionally, “retaining structure” was also rated as difficult components to maintain and operate in this cluster. The mean value and significant index with rank analysis are illustrated in Table 5. This component consists mean value and important index 3.49 and 0.70 respectively. This group comprises four major highway components as presented in Table 5. The analysis of the respondents’ perception of highway components data revealed that the most difficult drainage components for maintaining, as shown in Table 5, were: “drain cover”, “sump” and “drain”. The respondents perceived that “drain cover” is the most difficult to operate and maintain with calculated high important index 0.746. The average result of all respondents represents that “sump” was rated as the second most difficult components in this group, with a mean value and important index of 3.21 and 0.643 separately. Additionally, “drain” was also rated as difficult components to maintain and operate in this cluster. The mean value and significant index with rank analysis are illustrated in Table 5. This component consists mean value and important index 3.06 and 0.611 respectively. This group comprises two major highway components as presented in Table 5. The analysis of the respondents’ perception of highway components data revealed that the most difficult bridges and other structure components for maintaining, as shown in Table 5, were: “above ground bridge (road bridge, pedestrian/ motorcycle bridge)”, “special structures (underpass/vehicular box culverts, tunnel)”. The respondents perceived that “above ground bridge (road bridge, pedestrian/ motorcycle bridge)” is the most difficult to operate and maintain with calculated high important index 0.843. The average result of all respondents represents that “special structures (underpass/vehicular box culverts, tunnel)” was rated as the second most difficult components in this group, with a mean value and important index of 3.57 and 0.714 separately.

This group comprises nine major highway components as presented in Table 5. The analysis of the respondents’ perception of highway components data revealed that the most difficult traffic/road furniture components for maintaining, as shown in Table 5, were: “pavement markings”. “electrical devices” and “traffic calming devices”. The respondents perceived that “pavement markings” is the most difficult to operate and maintain with calculated high important index 0.906. The average result of all respondents represents that “electrical devices” was rated as the second most difficult components in this group, with a mean value and important index of 3.99 and 0.797 separately. Additionally, “traffic calming devices” was also rated as difficult components to maintain and operate in this cluster. The mean value and significant index with rank analysis are illustrated in Table 5. This component consists mean value and important index 3.94 and 0.789 respectively. Table 5 shows the overall group assessment and an average rating of the different highway components. All the group components have an average score above 3 and ranged 3.10 to 3.90. Therefore, it can be concluded that all the identified highway components are deemed important by respondents. In regard to all highway components, “bridges and other structure components” received the highest group rating from the respondents. The result is in the lines of earlier literature that

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

found different bridges and other structural components may become very costly and difficult to maintain while scheduled maintenance is not followed in a timely manner. Although these results differ from some published studies, they are consistent with the traffic/road furniture components is difficult to maintain; therefore, leads to higher annual maintenance costs.

Table 6: Overall group assessment

Highway Components	Group Mean	Group RII	Rank
Road Surface Components	3.25	0.649	4
Slope and Retaining Structure Components	3.37	0.673	3
Drainage Components	3.13	0.625	5
Bridges and other structure Components	**3.89**	**0.779**	**1**
Traffic/Road Furniture Components	3.79	0.758	2

Thereafter, statistically assessed 15 highway components out of 23 rated as "important" or "very important" by the respondents with a mean score of ≥ 3.41, as illustrated in Table 7. Among them above ground bridge (road bridge, pedestrian/ motorcycle bridge) and pavement markings are only rated as very important, other 13 rated as important. The rating is classified in categories as per Table 3.9 in section 3.5.3.

Table 7: The level of importance of highway components based on rating

	Highway Components	Mean	Indicator
	Road Surface Components		
1	Shoulder & Verge	3.73	Important
2	Median	3.79	Important
	Slope and Retaining Structure Components		
3	Retaining Structure	3.49	Important
4	Above Ground Services	3.83	Important
5	Slope Furniture	3.76	Important
	Drainage Components		
6	Drain Cover	3.73	Important
	Bridges and other structure Components		
7	Above Ground Bridge (Road Bridge, Pedestrian/ Motorcycle Bridge)	4.21	Very Important
8	Special Structures (Underpass/Vehicular Box Culverts, Tunnel)	3.57	Important
	Traffic/Road FurnitureComponents		
9	Pavement Markings	4.53	Very Important
10	Traffic Signs	3.89	Important
11	Traffic Calming Devices	3.94	Important
12	Traffic Sign	3.81	Important
13	Electrical Devices	3.99	Important
14	Pedestrian Facilities	3.81	Important
15	Traffic Barriers	3.76	Important

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Finally, to investigate the relationship between the top 10 factors of O&M cost and highway components, a Spearman correlation test was performed. The statistical results are given in Table 8. Each of the 10 factors has at least one building component significantly correlated to increase O&M cost in the post-construction phase.

Table 8: Correlation Between O&M Costs and Highway Components

Rank	Factors affecting O&M cost	Pavement Markings	Above Ground Bridge	Electrical Devices	Traffic Calming Devices	Traffic	Above Ground Services	Traffic Sign	Pedest. Fac	Median	Traffic Barriers	**Total number of significant correlations**
1	Poor Road Design	0.424[b]	0.415[b]	0.232	0.226	0.297	0.167	0.17	0.188	0.154	0.361	**10**
2	Lack of Maintenance Plan	0.506[a]	0.484[b]	0.504[a]	0.525[a]	0.373	0.388	0.399[b]	0.498[b]	0.379	0.460[b]	**10**
3	Increased maintenance cost due to lower maintenance quality		0.207	0.347	0.350	0.269	0.174	0.146			0.107	**7**
4	Poor Construction Quality		0.177	0.279	0.283	0.102						**4**
5	Risk of Corruption		0.292	0.432[b]	0.441[b]	0.227	0.236	0.211		0.138	0.189	**8**
6	Weather and Climate Condition		0.302	0.453[b]	0.461[b]	0.316	0.256	0.231		0.157	0.144	**8**
7	Initial and operational fund unavailability		0.384	0.528[a]	0.548[a]	0.404[b]	0.326	0.302*	0.114	0.227	0.298	**9**
8	Lack of Qualified Staff		0.139	0.365	0.370	0.175	0.157	0.125				**6**
9	Workmanship		0.479[b]	0.578[a]	0.596[a]	0.486[b]	0.366	0.343	0.163	0.266	0.380	**9**
10	Lack of Strong Governance	0.004	0.369	0.590[a]	0.551[a]	0.354	0.532[a]	0.513[a]	0.261	.427[b]	0.314	**9**
Total number of significant correlations		**3**	**10**	**10**	**10**	**10**	**9**	**9**	**5**	**7**	**8**	

Note: Bold values highlights the top most nine correlation values.
[a]Correlation is significant at the 0.01 level (two-tailed).
[b]Correlation is significant at the 0.05 level (two-tailed)

The nine highway components with the highest number of significant correlations were above ground bridge (ten), electrical devices (ten), traffic calming devices (ten), traffic (ten), above ground services(nine), traffic sign(nine), traffic barriers (eight), median (seven) and pedestrian facilities(five). On the other hand, the nine factors having the highest number of significant relationships with highway components were poor road design (ten), lack of maintenance plan (ten), initial and operational fund unavailability (nine), workmanship (nine), lack of strong governance (nine), risk of corruption (eight), weather and climate condition (eight) and increased maintenance cost due to lower maintenance quality (seven), thus minimizing operation and maintenance cost.

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Discussion

This research grounded in the relative importance of O&M cost factors and highway components, devised a relationship between factors and components for highway projects. This research focuses on a variety of factors that affect the O&M cost, as detailed in Table 3. The analysis demonstrated that O&M cost is strongly affected by poor road design, which had the highest RII value of 0.977. In Table 4, this was also highlighted as the significant factor (p =0.000) contributing to increased O&M costs. Poor road designs are a result of incomplete working drawing, detailing, and specification by the design team. Therefore, unexpected variations in designed and costly maintenance and repair, as well as various defects appearing in highway components in the post construction phase can occur. (Femi, 2014) found that improving the road design quality can minimize O&M costs significantly. (Gatlin, 2013) asserted that a large number of maintenance expenditures can be minimized by reducing design faults. Moreover, (Yap Jeffrey Boon et al., 2017) concluded that cost-effectiveness can add value in highway projects by minimizing the design fault reoccurrence rate. Based on the ranking order in Table 3, the second highest rank is lack of maintenance plan (RII 0.974). Statistical analysis of this factor found a p value less than 0.05 (p = 0.002), which indicates a significant factor (Table 4). The absence of this factor is expected to generate high O&M costs. High maintenance cost due to lower maintenance quality (RII=0.860) was another key criteria for success of a highway project (Table 3). Poor construction quality would cause severe maintenance problem. In addition, maintainability and functionality issues emerge in the post construction phase. Risk of corruption would also cause severe maintenance problem. Spearman correlation coefficient value 0.823 (p =0.000) indicates that this is the most significant factor at the 0.01 level in this group, as listed in Table 4. Additionally, respondents highlighted weather and climate condition as the next significant factor, with a RII value of 0.849 (Table 3), that affect the operation and maintenance cost.To evaluate the agreement between different factors, the Spearman rank correlation was calculated (Table 4). The result indicates this factor had significant (p= 0.031) agreement at the 0.05 level. Another important factor was initial and operational fund unavailability (RII =0.846), as illustrated in Table 3. Rising maintenance costs is one of the major problems in a highway project. This issue is adversely affected by a lack of qualified staff and poor workmanship, which lead to below standard maintenance work and budget overruns. In this sector, Bangladesh largely depends on foreign funds. Consequently, to enhance work quality, it is much needed to conduct training for improving labor skills and knowledge (Ye et al., 2015). However, Table 4 indicates this is a less significant factor with a p value (p=0.392) greater than 0.05. Table 5 illustrates the ranking order (based on RII value) of highway components that affect the operation and maintenance as perceived by respondents. In this study, data analysis showed that various highway components that can potentially affect the O&M cost.

The top-ranking highway components were (1) pavement markings, (2) above ground bridge (road bridge, pedestrian/ motor cycle bridge), (3) electrical devices, (4) traffic calming devices, and (5) traffic. The statistical calculation of different highway components shows that bridges and other structure components (RII =0.779) are most difficult to operate and maintain, as indicated in Table 6. Therefore, bridges and other structure components should be the first priority due to their great impact on increasing O&M costs. This finding is in agreement findings of (Sohu et al., 2018) and (Oke et al., 2017). These findings indicate the different impact levels of bridges and other structure components and other highway components. However, bridges and other structure components both have a great impact on maintenance costs. Moreover, within the category of highway components, the bridges and other structure components group exhibited the highest importance index value (RII =0.779). The authors

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

believe that any defects appear in bridges and other structure components are extremely difficult due to costly solutions. Consequently, additional unforeseen costs during the operational stage of a highway project affect the annual maintenance budget. Finally, the level of importance of the O&M cost factor and the highway components was ranked and correlated (Table 7). The Spearman correlation test revealed at least one highway component to be significantly correlated with factors increasing O&M costs.

Conclusion

Highway maintenance is becoming a top priority for modern roads in order to balance decreasing O&M costs and increasing quality road maintenance. Balancing these two characteristics requires a systematic analysis or grading of their major factors. The construction department in Bangladesh is showing progressive development at present. Through the methodology developed in this research, 22 factors and 23 highway components were initially identified from a comprehensive literature analysis. This was followed by a questionnaire survey, and 70 respondents graded them in a fivepoint Likert scale during an online survey. The factors and highway components were ranked accordingly using RII value; prior to this, the mean value and SD were computed using SPSS. From the primary data analysis, this study demonstrated that factors affecting O&M cost budget vary across projects, and general factors such as poor road design, lack of maintenance plan, high maintenance cost due to lower maintenance quality, poor construction quality, and risk of corruption are the five major factors affecting significantly O&M cost budget. Among highway components, pavement markings, above ground bridge (road bridge, pedestrian/ motorcycle bridge), electrical devices, traffic calming devices, and traffic were the top ranked for maintenance difficulty. Furthermore, correlation tests revealed a statistically significant relationship among poor road design, lack of maintenance plan, high maintenance cost due to lower maintenance quality, poor construction quality, and risk of corruption. Finally, statistical analysis showed that each of the top 10 ranked factors has at least one highway component significantly correlated to increase O&M cost budget. O&M costs are a major concern in Bangladesh highway projects and worldwide. To mitigate their impact on O&M cost budget some recommendations are made based on the insight of the results. First, construction quality should be improved which can help minimize their impacts on road maintenance. Next, proper maintenance planning should be incorporated in road design documents. Construction quality should be rich for minimizing operation and maintenance cost. Risk of corruption should reduce for decreasing operation and maintenance cost. Finally, adequate training can improve labor skills and productivity. This study has provided evidence of the most significant factors affecting O&M cost budget to further explore maintenance cost minimization. Furthermore, a case study approach is suggested to validate the importance of O&M cost factors on highway projects.

Acknowledgement

The author would like to thank the Ministry of Education (MOE) Malaysia through Research University Grant (RUG) No 1501 UTM funding project title Development of Biocement Using Ex Situ Mixing Technique for Construction Materials, for financial assistances while conducting this research project.

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

References

Ajao, A. M., Ogunbayo, B. F., Ogundipe, K. E., Bamigboye, G., Ogunde, A., & Tunji-Olayeni, P. F. (2018). Assessment of sandcrete blocks manufacturers 'compliance to minimum standard requirements by standard organisation of Nigeria in Southwest, Nigeria. *International Journal of Applied Engineering Research, 13*(6), 4162-4172.

Akmam Syed Zakaria, S., Gajendran, T., Rose, T., & Brewer, G. (2018). Contextual, structural and behavioural factors influencing the adoption of industrialised building systems: a review. *Architectural Engineering and Design Management, 14*(1-2), 3-26. doi:10.1080/17452007.2017.1291410

Al Nahyan Moza, T., Sohal, A., Hawas, Y., & Fildes, B. (2019). Communication, coordination, decision-making and knowledge-sharing: a case study in construction management. *Journal of Knowledge Management, 23*(9), 1764-1781. doi:10.1108/JKM-08-2018-0503

Ali, A. S., & Wen, K. H. (2011). Building defects: Possible solution for poor construction workmanship. *Journal of Building Performance, 2*(1).

Ameyaw, E. E., & Chan, A. P. C. (2015). Evaluation and ranking of risk factors in public–private partnership water supply projects in developing countries using fuzzy synthetic evaluation approach. *Expert Systems with Applications, 42*(12), 5102-5116. doi:https://doi.org/10.1016/j.eswa.2015.02.041

Aris, R. (2006). *Maintenance factors in building design.* Universiti Teknologi Malaysia.

Au-Yong, C. P., Ali, A. S., & AhmAd, F. (2014). Prediction cost maintenance model of office building based on condition-based maintenance. *Eksploatacja i Niezawodnosc-Maintenance and Reliability, 16*(2), 319-324.

Burke, R., & Demirag, I. (2015). Changing perceptions on PPP games: Demand risk in Irish roads. *Critical Perspectives on Accounting, 27*, 189-208. doi:https://doi.org/10.1016/j.cpa.2013.11.002

Chung, D., Hensher, D. A., & Rose, J. M. (2010). Toward the betterment of risk allocation: Investigating risk perceptions of Australian stakeholder groups to public–private-partnership tollroad projects. *Research in Transportation Economics, 30*(1), 43-58. doi:https://doi.org/10.1016/j.retrec.2010.10.007

De França, F. O., & Coelho, A. L. V. (2015). A biclustering approach for classification with mislabeled data. *Expert Systems with Applications, 42*(12), 5065-5075. doi:https://doi.org/10.1016/j.eswa.2015.02.045

De Silva, N., Dulaimi, M. F., Ling, F. Y. Y., & Ofori, G. (2004). Improving the maintainability of buildings in Singapore. *Building and Environment, 39*(10), 1243-1251. doi:https://doi.org/10.1016/j.buildenv.2004.02.011

El-Haram Mohamed, A., & Horner Malcolm, W. (2002). Factors affecting housing maintenance cost. *Journal of Quality in Maintenance Engineering, 8*(2), 115-123. doi:10.1108/13552510210430008

Fellows, R. F., & Liu, A. M. (2015). *Research methods for construction*. Oxford, UK: Blackwell.

Femi, O. T. (2014). Effects of faulty construction on building maintenance. *International Journal of Technology Enhancements and Emerging Engineering Research, 2*(3), 73-79.

Gatlin, F. (2013). Identifying and managing design and construction defects. *Construction Insight from Hindsight, 5*(2), 1-7.

Goh, K. C., Goh, H. H., Yap, A. B. K., Masrom, M. A. N., & Mohamed, S. (2017). Barriers and Drivers of Malaysian BIPV Application: Perspective of Developers. *Procedia Engineering, 180*, 1585-1595. doi:https://doi.org/10.1016/j.proeng.2017.04.321

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Hassanain Mohammad, A., Assaf, S., Al-Ofi, K., & Al-Abdullah, A. (2013). Factors affecting maintenance cost of hospital facilities in Saudi Arabia. *Property Management, 31*(4), 297-310. doi:10.1108/PM-10-2012-0035

Hussain, S., Fangwei, Z., Siddiqi, A. F., Ali, Z., & Shabbir, M. S. (2018). Structural equation model for evaluating factors affecting quality of social infrastructure projects. *Sustainability, 10*(5), 1415. doi:https://doi.org/10.3390/su10051415

Hwang, B.-G., & Yang, S. (2014). Rework and schedule performance: A profile of incidence, impact, causes and solutions. *Engineering, Construction and Architectural Management, 21*(2), 190-205. doi:10.1108/ECAM-10-2012-0101

Kamaruzzaman Syahrul, N., Myeda Nik, E., Zawawi Emma Marinie, A., & Ramli Rozita, M. (2018). Developing facilities management (FM) competencies for Malaysia: Reference from international practice. *Journal of Facilities Management, 16*(2), 157-174. doi:10.1108/JFM-08-2017-0036

Kamble, P., & Sanadi, N. (2019). Optimization of Time and Cost of Building Construction using Fast Tracking Method of Scheduling. *Optimization, 6*(07).

Karimi, H., Taylor, T. R. B., & Goodrum, P. M. (2017). Analysis of the impact of craft labour availability on North American construction project productivity and schedule performance. *Construction Management and Economics, 35*(6), 368-380. doi:10.1080/01446193.2017.1294257

Kärnä, S., & Junnonen, J.-M. (2017). Designers' performance evaluation in construction projects. *Engineering, Construction and Architectural Management, 24*(1), 154-169. doi:10.1108/ECAM-06-2015-0101

Khan, A. H., Imran, A., & Hussain, M. (2019). Evaluation of Quality during Construction Projects: A Case Study of Pakistan. *Mehran University Research Journal of Engineering and Technology, 38*(1), 69-82.

Lee, C. (2019). Financing method for real estate and infrastructure development using Markowitz's portfolio selection model and the Monte Carlo simulation. *Engineering, Construction and Architectural Management, 26*(9), 2008-2022. doi:10.1108/ECAM-10-2018-0440

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2014). *IBM SPSS for intermediate statistics: Use and interpretation*: Abingdon, UK: Routledge.

Ljevo, Ž., Vukomanović, M., & Džebo, S. (2018). Assessing the influence of project management on quality during the early phases of construction projects. *Organization, Technology and Management in Construction: an International Journal, 9*(1), 1584-1592. doi:https://doi.org/10.1515/otmcj-2016-0029

Lop, N. S., Ismail, K., & Isa, H. M. (2017). The implementation of key performance indicators in the Malaysian private finance initiative projects. *Environment-Behaviour Proceedings Journal, 2*(5), 95.

Mallawaarachchi, H., & Senaratne, S. (2015). *Importance of quality for construction project success.* Paper presented at the 6th Internafional conference on structural engineering and construcfion management 2015.

Mirdeeliana, A. (2012). *Customers satisfaction towards maintenance management in a government hospital building in Malaysia.* Paper presented at the Proc., 1st Int. Conf. on Innovation and Technology for Sustainable Built Environment.

Naji, H., Zehawi, R., & Hasan, Z. (2018). Managing Quality performance by Legislation in Iraqi Construction Projects: A system Dynamics Approach. *J. Eng. Appl. Sci, 13*, 8511-8519.

Neuman, W. L. (2006). Analysis of qualitative data in Social research methods: Qualitative and quantitative approaches (pp. 457–489.): London: Pearson Publishing.

Volume:7 Issues: 39 [March, 2022] pp. 125 - 143
International Journal of Accounting, Finance and Business (IJAFB)
eISSN: 0128-1844
Journal website: www.ijafb.com
DOI: 10.55573/IJAFB.073913

Oke, A., Aigbavboa, C., & Dlamini, E. (2017). *Factors Affecting Quality of Construction Projects in Swaziland*. Paper presented at the 9th International Conference on Construction in the 21st Century: Revolutionizing the Architecture, Engineering and Construction Industry through Leadership, Collaboration, and Technology, Dubai, United Arab Emirates.

Oladimeji, O., & Aina, O. O. (2018). Cash flow management techniques practices of local firms in Nigeria. *International Journal of Construction Management*, 1-9.

Pallant, J., & Manual, S. S. (2010). A step by step guide to data analysis using SPSS. *Berkshire UK: McGraw-Hill Education*.

Pan, W., & Thomas, R. (2015). Defects and Their Influencing Factors of Posthandover New-Build Homes. *Journal of Performance of Constructed Facilities, 29*(4), 04014119. doi:10.1061/(ASCE)CF.1943-5509.0000618

Roscoe, J. T. (1975). *Fundamental research statistics for the behavioral sciences* 2nd ed. New York: Holt, Rinehart and Winston.

Sohu, S., Ullah, K., Jhatial, A. A., Jaffar, M., & Lakhiar, M. T. (2018). Factors adversely affecting quality in highway projects of Pakistan. *International Journal of Advanced and Applied Sciences, 5*(10), 62-66.

Sousselier, T., Dreo, J., & Sevaux, M. (2015). Line formation algorithm in a swarm of reactive robots constrained by underwater environment. *Expert Systems with Applications, 42*(12), 5117-5127. doi:https://doi.org/10.1016/j.eswa.2015.02.040

Tam, V. W. Y., Fung, I. W. H., & Choi, R. C. M. (2017). Maintenance Priority Setting for Private Residential Buildings in Hong Kong. *Journal of Performance of Constructed Facilities, 31*(3), 04016115. doi:10.1061/(ASCE)CF.1943-5509.0000988

Tan, Y., Shen, L., Langston, C., Lu, W., & Michael, C. H. Y. (2014). Critical success factors for building maintenance business: A Hong Kong case study. *Facilities, 32*(5/6), 208-225. doi:10.1108/F-08-2012-0062

Waziri, B. S. (2016). Design and construction defects influencing residential building maintenance in Nigeria. *Jordan Journal of Civil Engineering, 10*(3), 313-323.

Yap Jeffrey Boon, H., Low Pak, L., & Wang, C. (2017). Rework in Malaysian building construction: impacts, causes and potential solutions. *Journal of Engineering, Design and Technology, 15*(5), 591-618. doi:10.1108/JEDT-01-2017-0002

Ye, G., Jin, Z., Xia, B., & Skitmore, M. (2015). Analyzing Causes for Reworks in Construction Projects in China. *Journal of Management in Engineering, 31*(6), 04014097. doi:10.1061/(ASCE)ME.1943-5479.0000347.