A Study of Cost Overruns in Complex multi-stakeholder Road Projects in the United Arab Emirates

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Abstract - Cost performance is a concern particularly for Complex multi-stakeholder projects in the form of critical infrastructure. Evidence suggests that critical infrastructure projects in the United Arab Emirates ('UAE') experience substantial cost overruns. Cost overruns and its consequences in terms of project failure can lead to substantial negative and unintended consequences on infrastructure project systems, especially noting that it is sector characterized by substantial interrelatedness and interdependence between different projects. For these reasons, understanding the causes and possible solutions to cost overruns as a form of project failure is of

This is a peer-reviewed, accepted author manuscript of the following article: Al Hosani, I. I. A., Dweiri, F. T., & Ojiako, U. (2020). A study of cost overruns in complex multi-stakeholder road projects in the United Arab Emirates. *International Journal of System Assurance Engineering and Management*, *11*(6), 1250-1259. https://doi.org/10.1007/s13198-020-00979-8

paramount importance. To undertake such a study, data were collected through structured questionnaire survey (focused on 44 common factors), of various project stakeholders with analysis focusing on frequency, severity and importance indices. Findings suggest five major reasons leading to cost overruns in UAE infrastructure projects as '*Delays in decisions making by approval authorities'*, '*Changes in client requirements*', '*Construction cost underestimation*', '*Poor site management'* and '*Frequency of variation orders and additional works*'.
Keywords – Cost overruns, factors, road projects

1. INTRODUCTION

1.1 Articulation

Complex multi-stakeholder projects are "…*projects characterised by complexity, stakeholder multiplicity, diversity and contradictions in their value systems and identities of their stakeholders*" (p.1). Generally, these projects tend to be sponsored and commissioned by "…*client organisations who maintain not only multiple cognitive and behavioural systems, but also multiple, heterogeneous, contradictory and contested ways of socially constructing their patterns of managerial assumptions, practices, beliefs and values*" (Ojiako et al. 2020; p.1). The ambiguity associated with these projects often requires well-orchestrated and articulate project management templates.

Infrastructure construction projects in the form of road projects have a vital role to play in the economic growth of any country. Providing efficient road network systems requires a distinct form of management which reflects positively on the society, economy, environment and sustainability. However, complex multi-stakeholder road projects as in the case of most critical infrastructure projects executed around the world face many challenges. One such challenge has to do with cost overruns (Lee 2008; Rajan et al. 2014; Love et al. 2015; Huo et al. 2018). There are numerous consequences (and unintended consequences) of these cost overruns, including project stakeholder dissatisfaction and disputes (Kisi et al. 2020; Sinha and Jha 2020). In the United Arab Emirates ('UAE'), while we do not have available precise information on failure rate of road projects, we are aware that infrastructure project rates in the country has been estimated to be as high as 50% by some scholars (see Faridi and El Sayegh 2006; Johnson and Babu 2018). This high rate of project failure across infrastructure projects in the country has created a claims dispute

industry which is extremely intense (Arcadis 2015, 2018; Mishmish and El-Sayegh 2018; Ojiako et al. 2018; Zaneldin 2018).

1.2 The concept of 'cost overruns'

Cost is one of the major considerations and significant factors relating to how the success or failure of complex multi-stakeholder project delivery (Muller et al. 2012; Chipulu et al. 2019). Cost is defined as the assigned expenses by client to successfully execute the target (Chitkara 2011). Drawing from the literature (see Avotos 1983; Love et al. 2015), our reference to *'cost overruns'* implies circumstances when a project experiences its final cost exceeding the original contract cost. Love et al. (2015) suggests that cost overrun implies "…*a budget increase, cost increase, or cost growth*" (p. 04014035-2). Cost overrun is sometimes construed as the cost variance between the actual cost of the project after completion and the assigned value (Kaka and Price 1991; Flyvbjerg et al. 2002; Kaliba et al. 2009; Sun and Meng 2009; Kasimu 2012). The essential attribute of '*cost overruns'* which differentiates it from *'cost escalations'* is that cost overruns are usually not anticipated (Love et al. 2015).

1.3 Aim of the study

To summate, over the last several years, the problem of cost overrun has become a major concern in projects. On the contrary, the literature on cost overrun in construction projects in the UAE is very limited to mainly to the works of El-Sayegh (Faridi and El-Sayegh 2006; El-Sayegh and Mansour 2015; Mishmish and El-Sayegh 2018) and Zaneldin (2006). With this in mind, the specific aim of this study is to generate an understanding of the causes and possible solutions to cost overruns as a form of project failure in the UAE. We undertake to achieve this aim by analysing the common factors deemed to impact on cost overruns of road projects and then subjecting such factors to assessment from a UAE perspective.

2. THE LITERATURE

The literature on cost overruns in cost overruns points to its pervasiveness in terms of complex multi-stakeholder projects in the road infrastructure sector. It is important at this point to highlight that the problems associated with cost overruns of complex multi-stakeholder projects in the form of critical road infrastructure projects is not peculiar to the UAE. As the literature does suggests,

this problem is universal in nature and has attracted the attention of scholars right across the world including from The Netherlands (Cantarelli et al. 2012), South Korea (Lee 2008), India (Rajan et al. 2014), UAE (Mishmish and El-Sayegh 2018) and the United States. For example, various studies conducted in the United States suggests that approximately 26% (Merewitz 1973), 77% (Cantarelli et al. 2010) or 85 % (Frame 1997) of road projects experienced cost overruns. Likewise, in Portugal, 39% of road projects experienced cost overruns (Moura 2007). It is therefore of no surprise that a number of scholars have focused their attention on examining the critical attributes of costs overruns. Of the several factors responsible for these cost overruns, scholars have cited factors such as poor decision making by senior management at the strategic decision-making level (Love et al. 2012), poor forecasting (Flyvbjerg 2013), poor change management and plan manipulation (Pinto 2013) and unchecked escalation of commitment (Winch 2013). Other factors driving cost overruns in road projects includes that of Flyvbjerg et al. (2004) who identified (i) duration of the project-implementation phase, (ii) project size and (iii) forms of project ownership as factors if not adequately addressed, were likely to lead to project cost overruns and escalations. Lee (2008) studied cost overrun in South Korean road projects finding evidence to support an assertion that factors such as (i) project scope changes and (ii) unreasonable estimates accounted for a substantial reason for such overruns experienced in road capital projects. In Kaliba et al. (2009), the focus was on Zambia where a number of factors (including weather conditions), were identified as the main drivers for cost overruns in road construction projects in Zambia. Over the years, we have found such studies conducted in a number of different national settings by various scholars such as Makovšek et al. (2012), Cantarelli et al. (2012), Rajan et al. (2014), El-Sayegh and Mansour (2015), El-Sayegh and Mansour (2015), Love et al. (2015), Huo et al. (2018), Mishmish and El-Sayegh (2018). However, from these studies, Cantarelli et al. (2010) is particularly interesting as they undertook a categorization of the different cost overrun factors into four groupings. These are (i) technical factors (ii) economic factors (iii) psychological factors and (iv) political factors. Most notably, they opined that the main driver for cost overruns in road infrastructure projects arose from political factors.

3 METHODOLOGY

3.1 Methodology Framework

The research was undertaken utilizing four steps which we now set out. First, we undertook a review of the literature on cost overruns. Second, we then identified a total of 44 factors driving cost overruns from the literature. These factors were then (as the third step), grouped into 9 distinct categories. We then (as the fourth step), conducted a questionnaire survey of project practitioners involved in the delivery of complex multi-stakeholder projects in the form of critical road infrastructure in the United Arab Emirates ('UAE'). The fifth step in our study then involved data analysis which was conducted utilizing indexing The final step in the study was to draw out a discussion based on the results emerging from the data analysis.

3.2 Questionnaire Survey Design

To gather relevant data (focused on the perception of project practitioners), we employed a questionnaire survey. This approach to data gathering remains popular in project management and has been adopted in previous similar studies focused on gaining an understanding of project success and failure perceptions. For example, such questionnaires were adopted by Chipulu et al. (2014) in their study focused on exploring how national values impacted upon the importance project practitioners assigned to both project success and project failure criteria.

In this study, our intention is to undertake a questionnaire survey of project practitioners based on 44 factors of cost overruns identified from our earlier review of the literature. These are show in Table 1 (below). These 44 factors were grouped into the literature review are listed into 9 categories as follow (i) materials, (ii) labour and equipment, (iii) financing, (iv) design and documentation, (v) management and organization, (vi) schedule, (vii) contractual issues, (viii) scope of work and (ix) external issues. Grouping followed a process where we examined each of the 44 factors individually, and based on face validity, we matched each factor against the nine deduced cost overrun factors based on '0' for 'not at all', '1' for 'somewhat matches this dimension' or 2 for 'very closely matches this dimension'. This is the approach utilised in Chipulu et al. (2019).

Table 1: Categorization of road project cost overrun factors

Categories	Materials	Labour and equipment	Financing	Design and documentation	Management and organization	Schedule	Contractual issues	Scope of work	External issues
Factors	Material delivery delay (Memon et al. 2011)	Low productivity (Long et al. 2004)	Delayed payment (Morris 1990; Mansfield et al. 1994; Apolot et al. 2012; Jamaludin et al. 2014)	Change design (Lee 2008; Jamaludin et al. 2014)	Information delay (Long et al. 2004)	Change schedule (Long et al. 2004)	Inappropriate bidding philosophy (Long et al. 2004)	Scope and specification changes (Long et al. 2004)	Weather conditions (Long et al. 2004)
	Supplier material monopolization (Long et al. 2004)	Poor work execution (Apolot et al. 2012)	Cash flow problems (Morris 1990; Mansfield et al. 1994; Jamaludin et al. 2014)	Errors and omission in design (Memon et al. 2011; Jamaludin et al. 2014)	Non earned value management assessment (Long et al. 2004)	Work stoppage rejections (Long et al. 2004)	Insufficient time for preparation of contract documents (Long et al. 2004)	Changes in client requirements (Long et al. 2004)	Accidents (Long et al. 2004)
	Price fluctuation (Azhar et al. 2008)	Labour shortage (Long et al. 2004)	High interest rates (Long et al. 2004)	Incomplete design drawings and specifications (Morris 1990; Mansfield et al. 1994; Apolot et al. 2012; Jamaludin et al. 2014)	Lack of cost planning/monitoring during pre and post contract stage (Long et al. 2004)		Discrepancies in contract documents (Mansfield et al. 1994)	Frequency of variation orders and additional works (Mansfield et al. 1994)	Information delays (Long et al. 2004)

	Material availability at local markets (Mansfield et al. 1994)	Mistakes during construction (Long et al. 2004)	Contractor's financial difficulties (Morris, 1990; Mansfield et al., 1994; Long et al. 2004; Jamaludin et al. 2014)	Delay in preparation and approval of drawing (Long et al. 2004)	Poor communication (Morris 1990; Jamaludin et al. 2014)		Project completion underestimation (Mansfield et al. 1994)	Project rework (Mansfield et al. 1994)	
	Minimal consultant knowledge (Long et al. 2004)	Equipment Unavailability (Long et al. 2004)	Skilled worker resourcing (Apolot et al. 2012)	Inaccurate quantity take-off (Long et al. 2004)	Insufficient coordination (Long et al. 2004)		Extension of time and cost claims (Mansfield et al. 1994)		
		Poor engineering experience (Long et al. 2004)		Long period from planning of project to construction (Long et al. 2004)	Delays in decisions making (Long et al. 2004; Memon et al. 2011)				
		Construction cost underestimate (Mansfield et al. 1994)							
		Poor site management (Long et al. 2004)							

3.3 Analysis Method

The collected data were analysed based on three types of indices: frequency, severity and importance and these were computed using the following formulae. This methodology was adopted before by Le-Hoai et al. (2012).

$$\text{Severity Index (SI) (\%)} = = [(\sum a_i n_i)/5N] \times 100 \quad (1)$$

$$\text{Frequency Index (F.I) (\%)} = [(\sum b_i n_i)/5N] \times 100 \quad (2)$$

$$\text{Importance Index (I.I) (\%)} = (\text{F.I} * \text{S.I}) / 100 \quad (3)$$

Where '*a'* and '*b'* are the constant and expressing the weighting given to each response, it ranges from 1 to 5, '*n'* is the frequency of each response, *N*= total number of responses. Ranking of variables is obtained using the importance index by assigning the first rank for the highest value, the second rank to the next highest value and so on.

4 RESULTS

4.1 Questionnaire Response Rate

Prior to the commencement of the 'final' data, we undertook a pilot of the draft questionnaire in order to obtain detailed feedback on not only user- friendliness of the survey instrument, but also feedback on our structuring of the constituent 44 measures of each group category. To undertake the pilot, we drew upon personal and professional networks of two of the three co-authors based in the United Arab Emirates. Guiding the structure of the questionnaire was the project experiment framing which was developed earlier by Pinto and Mantel (1990) and used most recently by Chipulu et al. (2019). For the pilot (and also, the final questionnaire), we sampled only respondents who could demonstrate their engagement with a road infrastructure project that had recently been completed (we determined 'recent' as being up to five years prior to the sampling). We first conducted six pilot studies – following which the questionnaire was refined and sent back for confirmation to the pilot participants. Only at this point did we commence gathering data. Although the survey was conducted in the United Arab Emirates ('UAE'), we the survey instrument was designed in English on the basis that while Arabic is the official language in the UAE, English is widely spoken and represents the unofficial language of business in the country. In total, we distributed 167 questionnaires (mainly directly via email) of which 143 valid responses

were obtained (this excludes questionnaires which we discarded because of substantial missing values). This distribution of the responses is as follows. Clients response rate was 32% (45 out of 58 respondents), Consultants response rate was 43% (62 out of 70 respondents) and Contractors response rate was 25% (36 out of 39 respondents).

4.2 Experience of Respondents

As shown in Figure 1 (below), the percentage of respondents based on relevant work experience in construction of road projects is as follows: 6% of the respondents had between 1 to 3 years of experience in the field, 4% of them had between 3 to 5 years, 14% had between 5 to 10 years, 32% had between 10 to 15 years, and 44% had more than 15 years of experience. Assessment of experiences of individual respondents shows that approximately 76% of total respondents had more than 10 years of experience (in road projects).

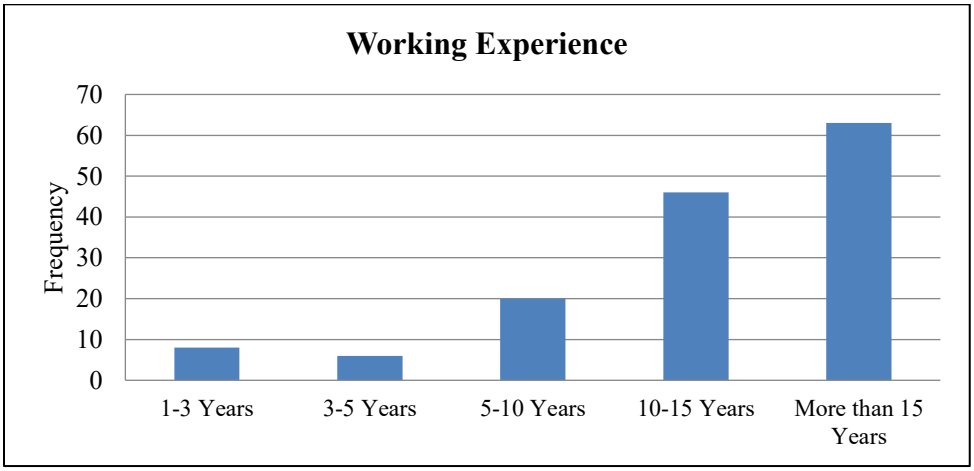

Figure 1: Relevant working experience

4.3 Respondent's Designation

Again, as had been undertaken in Chipulu et al. (2019), individual stakeholder respondents had been classified based on their project role. More specifically, individual stakeholder respondents had been asked during the survey to highlight the role option which in their view, most appropriately described their project role. These roles were designated to closely resemble those utilised in prior studies examining how project role impacted on perceptions of project success and project failure (Turner and Zolin 2012; Ojiako et al. 2014, 2015). Most importantly, the

designation of project role was undertaken in a manner to capture the wide variety of roles undertaken by project professionals across different stages and phases of road infrastructure projects (see Figure 2, below).

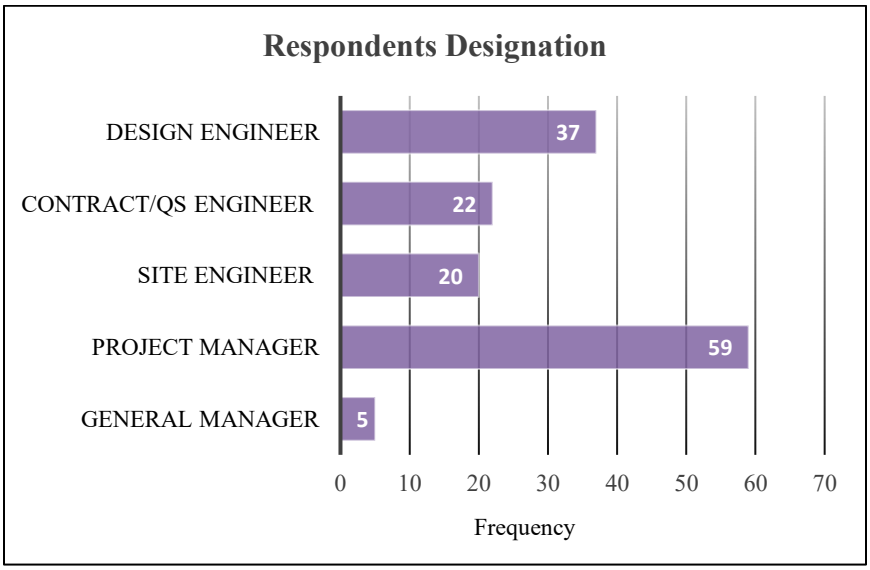

Figure 2: Respondent's designation

Majority of the respondents (96%) had verifiable working knowledge of projects which had experienced cost overruns. The data collected showed that respondents were drawn from three of the largest *emirates* (city states) within the United Arab Emirates. More specifically, 43% of respondents were drawn from the *Emirate* of Sharjah, 30% from the *Emirate* of Dubai and 27% from the *Emirate* of Abu Dhabi.

5 FINDINGS

The analysis shows the results of the questionnaire survey based on an assessment of the '*severity'*, '*frequency'* and '*importance'* of all factors of cost overruns within different categorizations. As shown in Table 2, we find that the factor of '*Delays in decisions making by the approval authorities'* is common across all three *emirates*. Also, the factors '*Cash flow problem during construction'*, '*Change design'*, '*Scope and specification changes*', '*Incomplete design drawings and specifications at tendering stage'* and '*Contractor's financial difficulties*' were found to be more severe in the *Emirate* of Sharjah; whereas, in the *Emirate* of Abu Dhabi and the *Emirate* of Dubai are less severe as ranked in high order. The results are as shown in Table 3; '*Delays in*

decision making by the approval authorities' were ranked as most significant across all emirates. In addition, '*Changes in client requirements*' is mostly frequent cause of cost overruns since it is ranked as fifth, sixth and fourth in the Emirates of Sharjah, Abu Dhabi and Dubai respectively. As well, '*Change design'*, '*Incomplete design drawings and specifications at tendering stage*' and '*Contractor's financial difficulties*' are ranked in high order on the *Emirates* of Abu Dhabi and Dubai when comparing to the *Emirate* of Sharjah. The importance indices were computed as product of severity and frequency indices in order to establish the most significant causes of cost overruns and rank all factors. As observed, it is found that '*Delays in decision making by the approval authorities'* is common factor in all emirates. '*Cash flow problem during construction'* factor is not considered too much important within the *Emirate* of Dubai. Some factors such as '*Frequency of variation orders and additional works'*, '*Incomplete design drawings and specifications at tendering stage'*, '*Errors and omission in design'* and '*Construction cost underestimation'* are very close in ranking within the *Emirates* of Abu Dhabi and Dubai.

Table 2: The top ten factors based on severity index

Factor	Rank in Sharjah	Rank in Abu Dhabi	Rank in Dubai
Changes in client requirements	1	4	6
Cash flow problem during construction	2	11	25
Delays in decisions making by the approval authorities	3	1	1
Change design	4	14	14
Frequency of variation orders and additional works	5	8	12
Scope and specification changes	6	18	11
Errors and omission in design	7	9	15
Incomplete design drawings and specifications at tendering stage	8	25	21
Contractor's financial difficulties	9	30	36
Construction cost underestimation	10	3	3

Table 3: The top ten factors based on frequency index

Factor	Rank in Sharjah	Rank in Abu Dhabi	Rank in Dubai
Delays in decisions making by the approval authorities	1	1	1
Change design	2	16	9
Frequency of variation orders and additional works	3	13	12
Incomplete design drawings and specifications at tendering stage	4	21	18

Changes in client requirements	5	6	4
Errors and omission in design	6	11	11
Scope and specification changes	7	20	13
Cash flow problem during construction	8	9	23
Contractor's financial difficulties	9	22	30
Construction cost underestimation	10	4	2

As shown in Figure 3, it is found that within the *Emirate* of Abu Dhabi, '*Delays in decision making by the approval authorities'*, '*Change in client requirement'* and '*Construction cost underestimation'* have higher value of important index when compared to the *Emirate* of Sharjah. Some factors such as '*Change design'*, '*Frequency of variation orders and additional works*', '*Cash flow problem during construction'* and '*Scope and specification changes'* mostly have same values of important indices in the *Emirates* of Sharjah and Abu Dhabi. However, in the *Emirate* of Dubai, most of factors have less important indices values when comparing to other emirates.

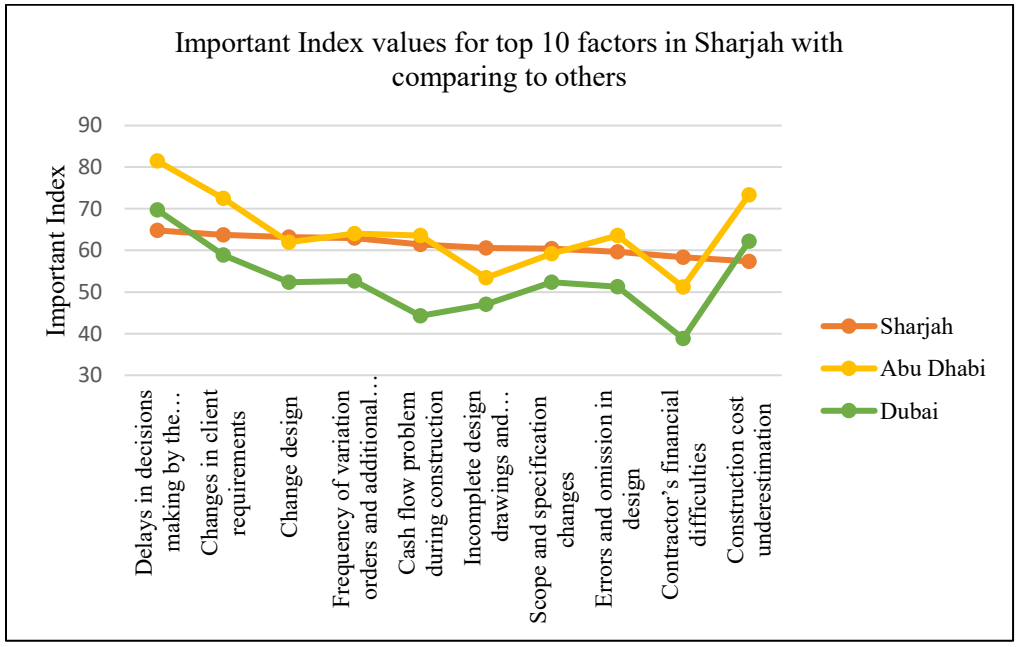

Figure 3: Important index for top factors in the *Emirate* of Sharjah with comparison to other *emirates*

As shown in Figure 4, the result of scope of work category indicates the greatest sources of cost overruns in the three emirates and is ranked first. Labour and equipment category is ranked second for both the *Emirates* of Abu Dhabi and Dubai, but is ranked second in the *Emirate* of Sharjah design and documentation category. The third rank in the *Emirate* of Sharjah is financing category

which is highly ranked when compared to the *Emirates* of Abu Dhabi and Dubai. Moreover, schedule category ranked seventh in all emirates although there are differences in values of importance indices between each one. Materials and external issues category have less important effect on causing cost overruns in all three *emirates*.

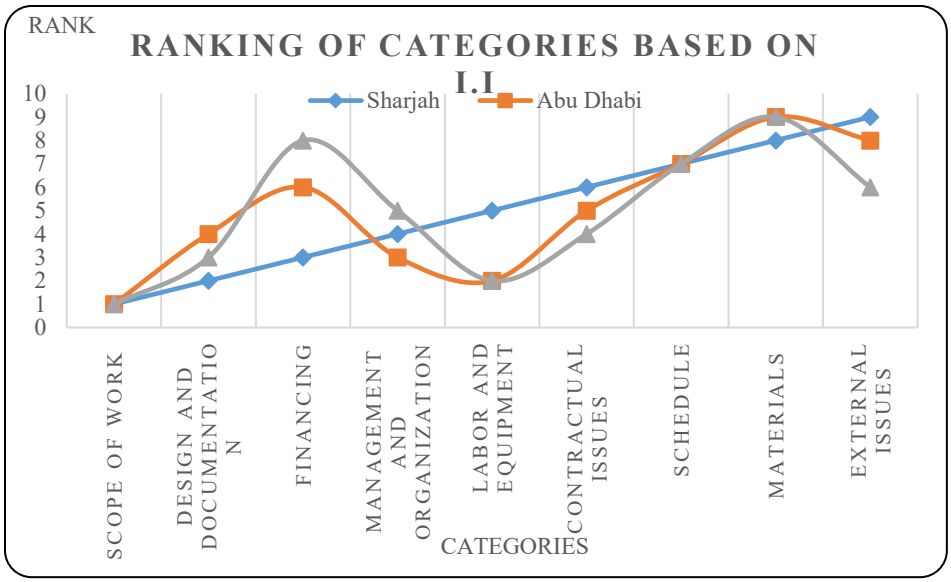

Figure 4: Important index of categories in different emirates

As shown in Table 4, when combining frequency, severity and importance indices for the categories of cost overruns in all emirates, it is found that the most '*frequent'*, '*severe'* and '*important'* cause of cost overruns is '*Scope of work'* category (which is ranked first). Likewise, '*Design and documentation'* ranked second most significant.

Table 4: Ranking of categories for all emirates

No	Category	II	Rank
1	Materials	35.18	9
2	Labor and equipment	51.82	3
3	Financing	46.40	6
4	Design and documentation	55.03	2
5	Management and organization	50.77	4
6	Schedule	42.43	7
7	Contractual issues	47.18	5
8	Scope of work	57.62	1
9	External issues	39.51	8

6 CONCLUSION

Cost overruns appear to have had considerable challenging consequences on the effectiveness of road construction projects in the UAE, and more so specifically, within the Emirate of Sharjah. The findings from our study suggests that the two major drivers for such cost overruns is '*Scope of work'* and '*Design and documentation'.* We posit that the findings from this study takes us in two directions. The first direction is the need for more collaboration in project governance. Increasingly as has been shown in the academic literature (see for example, Ojiako et al. 2015; Chipulu et al. 2019), collaborative forms of project governance have increasingly become a popular means of delivery complex multi-stakeholder infrastructure projects. The attractiveness of this approach being that its key attributes ('*Inclusiveness'*, '*Forums'* and '*Procedural transparency'* – see Ojiako et al. 2015), focuses on decision making among stakeholders in a manner which is consensual and engaging. The second direction that the findings points to is the increasing need for '*risk intelligence'* in complex multi-stakeholder projects. This is an emergent idea that has developed from forecasting research undertaken by Marshall (2019). 'Risk intelligence' within the context of projects implies that project based organisations increasingly develop their professionalism (competence) in being able to seek, collect, analyse and apply information gleaned from a number of different sources, including project manager insight in order to avert, cater and manage project risks. Contextualized within our current study findings, applying *'risk intelligence'* to the two main drivers for cost overruns which emerged from our study, that is '*Scope of work'* and '*Design and documentation',* will imply project management practitioners being encouraged to draw upon their professionalism (competency) and insight to seek, collect, analyse and apply information gleaned from a number of different sources to ensure that not only is project work appropriately scoped, but also that necessary design and documentation is readily to support effective project decisions.

In light of our study findings suggesting the need to focus on collaborative governance and risk intelligence, future studies are recommended along the following lines. In terms of collaborative governance, it is likely that we do require future studies to begin to examine the different collaborative means by which project management practices in will be able to orchestrate project-level performance. This is especially so in a manner which is ambidextrous. The notion of ambidexterity will increasingly be a topic of interest, especially within the United Arab Emirates as the country increasingly focuses on its Centennial Vision 2057. In this regard, we are mindful

of recent research in the United Arab Emirates addressing not only a project focused definition of ambidexterity (Petro et al. 2019a), but also research that has focused our attention on the use of projects to orchestrate ambidexterity (Petro et al. 2019b). In terms of risk intelligence, drawing upon the recent works of Marshall (et al. 2019a,b) and Al-Mazrouie et al. (2020), a '*risk intelligent'* philosophy for cost overruns may serve as a means of ensuring readiness. In this context, the emphasis will be for the development of mechanism (managerial action), that ensures that critical readiness factors frequently driving cost overruns are known (based on both abstract and concrete knowledge) and addressed prior to manifesting in projects.

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