**Analyzing factors affecting Road Construction Delay in UAE**

K. Rupesh Rao

2nd Year Electronics and Communication Engineering, Jalpaiguri Government Engineering College, Jalpaiguri, West Bengal, India

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**Abstract:**

Road Construction projects in UAE are experiencing widespread delays. Using a selected set of 44 attributes, this research identified the key factors impacting delay in road construction industry. A questionnaire and personal interviews have formed the basis of this research. The research includes: (1) ranking the factors on the basis of frequency of the factors; (2) ranking the factors on the basis of severity of the factors; and (3) taking both into consideration. The research includes only three states/emirates, namely, Abu Dhabi, Dubai and Sharjah. Separate analysis is also done for the different states. From the factor analysis, most critical factors of road construction delay were identified as: (1) Delays in decisions making by the approval authorities; (2) Frequency of variation orders and additional works; (3) Scope and specification changes; (4) Change design; (5) Extension of time with cost claims; (6) Delay in preparation and approval of drawing; and (7) Underestimation of time for completion of project. An analysis is also made on the cost overrun in road construction industry in the three states/emirates. These findings are expected to be significant contributions to road construction industry in controlling the time overruns and cost in constructions contracts.

**Keywords:**  Time delay, UAE road projects, Abu Dhabi, Dubai, Sharjah, factor ranking.

**Introduction:**

A construction project is commonly admitted as successful when it complete on time, with budget, according the specifications, and stakeholder satisfaction. However, most of the projects did not finish as the expected timetable. Instead, they completed before or after the schedule due to uncertainties of events and its uniqueness . Construction projects experienced 70% of time overruns and 76% of contractors and 56% of consultants have indicated that they have been facing average time overrun of 10 to 30% from the original duration that causes 50% cost overrun. Elsewhere, 50% of the construction projects in the United Arab Emirates (UAE) encountered construction delay. Therefore, delay considered as one of the most common problems causing a multitude negative effect on projects, and its participating parties. Ethiopia one of the fastest growing, developing country; uses construction industry as the main input for growth, employment, and infrastructure expansion. Yet, not contributed to the development of the country as desired due to it faces various problems, limitations, and drawbacks. Among those, impact of delay in construction project is a common, and a predominant. Various researchers had been studying the causes and effects of delays in construction projects all over the world and in domestic in numerous manners for decades. The problem studied in different countries with different scholars; due to the reason that, it differs from one country to another; in time variation or even one project to another. And to find the various factors and groups of factors that causing delay. Some of those countries that investigated the problem of the causes and effects of delay include; China; Thailand; India; Nigeria; Ghana; Egypt; Saudi Arabia; UAE and Iran.

**Literature Review**

Many studies have been conducted to identify the causes of delay in construction projects. Chan et al. (1997) indicated that the five principal causes of delays in Hong Kong construction projects are: poor site management and supervision, unforeseen ground conditions, low speed of decision making involving all project teams, client-initiated variations and necessary variations of works. In a survey of the West Bank in Palestine, Mahamid (2011) indicated that the most severe factors affecting time delay in road construction projects from the owners’ perspective are: poor communication between construction parties, poor resource management, delays in commencement, insufficient inspectors, and rework. Similarly, Al-Najjar (2008) concluded that the most important factors causing time overruns in building construction projects in the Gaza Strip as perceived by contractors were: strikes, Israeli attacks and border closures, lack of materials in the markets, shortage of construction materials at site, delays of material deliveries to site, cash shortages during construction, poor site management, poor economic conditions (currency, inflation rate, etc), shortage of equipment and tools on site, and owner delay in freeing the contractors payments for completed work. Examining the factors that cause delay in construction projects in Malaysia, Alghbari et al. (2007) tested 31 variables. The main finding of the study was that financial factors are the most common cause of delays in construction projects in Malaysia. Coordination problems are considered the second most important factor causing delays, followed by materials problems.

A survey to identify project delays in Saudi Arabia was conducted by Al-Khalil and Al-Ghafly (1999) reporting lack of agreement between project stakeholders in such identification. Al-Kharashi and Skitmore (2009) repeated this study in Saudi Arabia to highlight the chronic nature of the problem and disparity in the views of the project stakeholders. Olawale and Sun (2010) reported a study conducted in the UK to determine inhibiting factors and mitigating measures in practice relating to time and cost overruns on construction projects in the country. Nkadoa (1995) studied the issue of time performance of construction projects in UK from the contractors' perspective. Ling and Hoi (2006) provided time performance guideline for Singaporean contractors working in India. From the above selected literature review, it has been apparent that in most studies, priority has been given to identifying the critical causes based on perceptions of different parties in construction. Work is yet to be done in identifying the relationship between the various reasons of delay and also prediction of impact on that delay.

**Research Methodology**

For this research, a questionnaire survey approach has been adopted to find the impact of various attributes on delay in the Indian construction sector drawing from various international researchers mentioned above. A survey of construction professionals representing various stakeholders involved in construction projects in India was conducted. Heterogeneity of respondents is an important criteria in capturing the impact of various attributes on construction delay (Sambasivan and Soon, 2007). In this study, the heterogeneity in the survey sample was maintained by approaching to the selected group of respondents representing the key industry roles across the construction sector.

* Preparation of questionnaire:

Identification of critical attributes for the study and preparation of questionnaire is a crucial step for the success of the research. Significant amount of work has already been done on causes of construction delay and there is a well documented and peer-reviewed set of delay attributes available in the literature.

For this research, the questionnaire has been prepared by incorporating the key delay attributes reported in the literature. A total of 44 delay attributes were identified under six broad

categories namely (1) Material; (2) Labor and Equipment; (3) Financing; (4) Design and Documentation; (5) Management and Organization; (6) Schedule; (7) Contractual Issues; (8)

Scope of work; and (9)External issues. A five point Likert scale (1 very low, 2 low, 3 moderate, 4 high, 5 very high) was adopted where respondents were asked to rank the frequency and severity of a particular attribute on delay in one of their selected projects. The research was designed to be used with the statistical technique namely factor analysis.

* Respondent’s Profile:

Respondents are selected from a wide range of professionals engaged in the Indian construction sector (contractors, clients and engineers). All the respondents identified had experience in relatively large engineering road projects in the UAE context. The sample consisted of owners, architects, structural engineers, service engineers, project managers, contract administrators, design managers and construction managers. As seen, the mix of disciplines was well proportioned in the sample. In order to get the best possible response commensurate by the experience and expertise, introductory conversations and email contacts were made with each respondent to explain and make the objectives of the research clear. A total of 143 respondents

filled the questionnaire. Though the sample size is relatively small, the quality of the responses was considered to be highly reliable for the analysis due to relevant industry experiences,

personal level interactions and clear understanding of the questionnaires among the respondents.

Table 1

Identification of Attributes

|  |  |
| --- | --- |
| Category | Attribute affecting delay |
| 1. Material | 1.Delay in delivering material to construction site |
| 2. Monopoly of material by some suppliers |
| 3. Prices fluctuation |
| 4. Types of material availability at local market |
| 5. Lack of consultant’s knowledge of available materials |
| 2.Labour and equipment | 6. Low productivity |
| 7. Poor work execution |
| 8. shortage of laborers |
| 9. Mistakes happens during construction phase |
| 10.Unavailability of equipments |
| 11. Lack of engineering experience |
| 12. Construction cost underestimation |
| 13. Poor site management |
| 3. Financing | 14. Delayed payment for completed work |
| 15. Cash flow problem during construction |
| 16. High rate of interest |
| 17. Contractor’s financial difficulties |
| 18. Increase in salaries of skilled laborers |
| 4. Design and Documentation | 19. Change design |
| 20. Errors and omission in design |
| 21. Incomplete design drawings and specifications at tendering stage |
| 22. Delay in preparation and approval of drawing |
| 23. Inaccurate quantity take-off |
| 24. Long period from planning of project to construction |
| 5. Management and Organization | 25. Delays in issuing information to the contractor during construction stage |
| 26. No practical use of earned value management system |
| 27. Lack of cost planning/monitoring during pre and post contract stage |
| 28. Poor communication between client, consultant and contractor |
| 29. Insufficient coordination between local authority who is responsible about road projects and service authorities |
| 30. Delays in decisions making by the approval authorities |
| 6. Schedule | 31. Change schedule |
| 32. Stoppages because of work being rejected by consultant |
| 7. Contractual Issues | 33. Lowest bid price |
| 34. Insufficient time for preparation of contract documents |
| 35. Discrepancies in contract documents |
| 36. Underestimation of time for completion of project |
| 37. Extension of time with cost claims |
| 8. Scope of work | 38. Scope and specification changes |
| 39. Changes in client requirements |
| 40. Frequency of variation orders and additional works |
| 41. Rework due to error in execution |
| 9. External Issues | 42. Weather conditions |
| 43. Accidents during construction |
| 44. Delay in getting NOCs from different government authorities |

* Ranking of Attributes:

Ranking of attributes is done by calculating Frequency index, Severity index and Importance index.

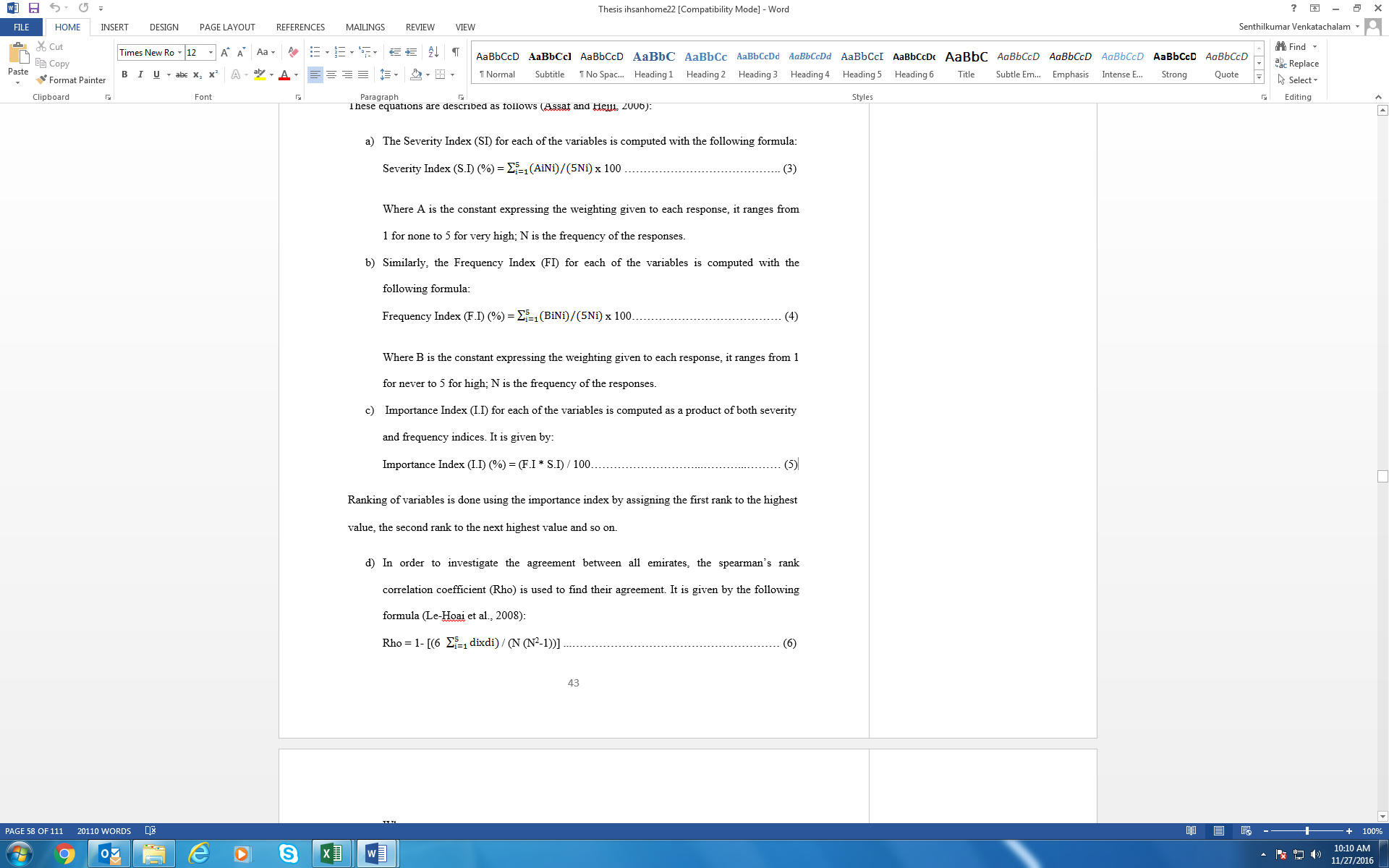


Table 2

Ranking of Attributes for Abu Dhabi based Importance Index

|  |  |  |
| --- | --- | --- |
| **Attributes Causing Delay** | **Importance index** | **Rank** |
| 40.Frequency of variation orders and additional works | 0.008021 | 1 |
| 39.Changes in client requirements | 0.007571 | 2 |
| 38.Scope and specification changes | 0.007411 | 3 |
| 30.Delays in decisions making by the approval authorities | 0.007404 | 4 |
| 44.Delay in getting NOCs from different government authorities | 0.007261 | 5 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.006811 | 6 |
| 28.Poor communication between client, consultant and contractor | 0.006778 | 7 |
| 22.Delay in preparation and approval of drawing | 0.006567 | 8 |
| 37.Extension of time with cost claims | 0.006499 | 9 |
| 7.Poor work execution | 0.006321 | 10 |
| 15.Cash flow problem during construction | 0.00624 | 11 |
| 14.Delayed payment for completed work | 0.006184 | 12 |
| 31.Change schedule | 0.006092 | 13 |
| 20.Errors and omission in design | 0.005993 | 14 |
| 12.Construction cost underestimation | 0.005934 | 15 |
| 10.Unavailability of equipment | 0.005923 | 16 |
| 6.Low productivity | 0.005877 | 17 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.005864 | 18 |
| 36.Underestimation of time for completion of project | 0.005787 | 19 |
| 23.Inaccurate quantity take-off | 0.005732 | 20 |
| 19.Change design | 0.005712 | 21 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.005607 | 22 |
| 24.Long period from planning of project to construction | 0.005345 | 23 |
| 11.Lack of engineering experience | 0.005325 | 24 |
| 8.Shortage of laborers | 0.005313 | 25 |
| 41.Rework due to error in execution | 0.005292 | 26 |
| 35.Discrepancies in contract documents | 0.005091 | 27 |
| 25.Delays in issuing information to the contractor during construction stage | 0.005014 | 28 |
| 17.Contractor’s financial difficulties | 0.004952 | 29 |
| 34.Insufficient time for preparation of contract documents | 0.00494 | 30 |
| 26.No practical use of earned value management system | 0.004914 | 31 |
| 9.Mistakes happens during construction phase | 0.004718 | 32 |
| 33.Lowest bid price | 0.004679 | 33 |
| 13.Poor site management | 0.004547 | 34 |
| 16.High rate of interest | 0.004482 | 35 |
| 32.Stoppages because of work being rejected by consultant | 0.004412 | 36 |
| 18.Increase in salaries of skilled laborers | 0.004216 | 37 |
| 1.Delay in delivering material to construction site | 0.004019 | 38 |
| 4.Types of material availability at local market | 0.003775 | 39 |
| 5.Lack of consultant’s knowledge of available materials | 0.003567 | 40 |
| 43.Accidents during construction | 0.003251 | 41 |
| 3.Prices fluctuation | 0.003029 | 42 |
| 2.Monopoly of material by some suppliers | 0.002902 | 43 |
| 42.Weather conditions | 0.002785 | 44 |

Table 3

Ranking of attribute for Dubai based Importance Index

|  |  |  |
| --- | --- | --- |
| **Attributes causing delay** | **Importance index** | **Rank** |
| 30.Delays in decisions making by the approval authorities | 0.0072 | 1 |
| 39.Changes in client requirements | 0.006927 | 2 |
| 13.Poor site management | 0.006585 | 3 |
| 38.Scope and specification changes | 0.006568 | 4 |
| 37.Extension of time with cost claims | 0.006455 | 5 |
| 36.Underestimation of time for completion of project | 0.006403 | 6 |
| 11.Lack of engineering experience | 0.00622 | 7 |
| 7.Poor work execution | 0.006062 | 8 |
| 41.Rework due to error in execution | 0.005846 | 9 |
| 44.Delay in getting NOCs from different government authorities | 0.005776 | 10 |
| 12.Construction cost underestimation | 0.005727 | 11 |
| 6.Low productivity | 0.005699 | 12 |
| 19.Change design | 0.005695 | 13 |
| 40.Frequency of variation orders and additional works | 0.005652 | 14 |
| 22.Delay in preparation and approval of drawing | 0.0055 | 15 |
| 23.Inaccurate quantity take-off | 0.005316 | 16 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.005303 | 17 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.005222 | 18 |
| 17.Contractor’s financial difficulties | 0.005163 | 19 |
| 24.Long period from planning of project to construction | 0.005161 | 20 |
| 35.Discrepancies in contract documents | 0.00516 | 21 |
| 14.Delayed payment for completed work | 0.005106 | 22 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.004987 | 23 |
| 15.Cash flow problem during construction | 0.004911 | 24 |
| 33.Lowest bid price | 0.004907 | 25 |
| 25.Delays in issuing information to the contractor during construction stage | 0.004899 | 26 |
| 31.Change schedule | 0.004751 | 27 |
| 8.Shortage of laborers | 0.004736 | 28 |
| 20.Errors and omission in design | 0.00443 | 29 |
| 10.Unavailability of equipment | 0.00443 | 30 |
| 9.Mistakes happens during construction phase | 0.004402 | 31 |
| 34.Insufficient time for preparation of contract documents | 0.004395 | 32 |
| 1.Delay in delivering material to construction site | 0.004392 | 33 |
| 28.Poor communication between client, consultant and contractor | 0.004255 | 34 |
| 2.Monopoly of material by some suppliers | 0.004198 | 35 |
| 16.High rate of interest | 0.004188 | 36 |
| 26.No practical use of earned value management system | 0.004158 | 37 |
| 32.Stoppages because of work being rejected by consultant | 0.004012 | 38 |
| 4.Types of material availability at local market | 0.003987 | 39 |
| 3.Prices fluctuation | 0.003759 | 40 |
| 5.Lack of consultant’s knowledge of available materials | 0.003729 | 41 |
| 43.Accidents during construction | 0.003614 | 42 |
| 18.Increase in salaries of skilled laborers | 0.003012 | 43 |
| 42.Weather conditions | 0.002974 | 44 |

Table 4

Ranking of attributes for Sharjah based on Importance Index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Importance index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.0072 | 1 |
| 39.Changes in client requirements | 0.006927 | 2 |
| 13.Poor site management | 0.006585 | 3 |
| 38.Scope and specification changes | 0.006568 | 4 |
| 37.Extension of time with cost claims | 0.006455 | 5 |
| 36.Underestimation of time for completion of project | 0.006403 | 6 |
| 11.Lack of engineering experience | 0.00622 | 7 |
| 7.Poor work execution | 0.006062 | 8 |
| 41.Rework due to error in execution | 0.005846 | 9 |
| 44.Delay in getting NOCs from different government authorities | 0.005776 | 10 |
| 12.Construction cost underestimation | 0.005727 | 11 |
| 6.Low productivity | 0.005699 | 12 |
| 19.Change design | 0.005695 | 13 |
| 40.Frequency of variation orders and additional works | 0.005652 | 14 |
| 22.Delay in preparation and approval of drawing | 0.0055 | 15 |
| 23.Inaccurate quantity take-off | 0.005316 | 16 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.005303 | 17 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.005222 | 18 |
| 17.Contractor’s financial difficulties | 0.005163 | 19 |
| 24.Long period from planning of project to construction | 0.005161 | 20 |
| 35.Discrepancies in contract documents | 0.00516 | 21 |
| 14.Delayed payment for completed work | 0.005106 | 22 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.004987 | 23 |
| 15.Cash flow problem during construction | 0.004911 | 24 |
| 33.Lowest bid price | 0.004907 | 25 |
| 25.Delays in issuing information to the contractor during construction stage | 0.004899 | 26 |
| 31.Change schedule | 0.004751 | 27 |
| 8.Shortage of laborers | 0.004736 | 28 |
| 20.Errors and omission in design | 0.00443 | 29 |
| 10.Unavailability of equipment | 0.00443 | 30 |
| 9.Mistakes happens during construction phase | 0.004402 | 31 |
| 34.Insufficient time for preparation of contract documents | 0.004395 | 32 |
| 1.Delay in delivering material to construction site | 0.004392 | 33 |
| 28.Poor communication between client, consultant and contractor | 0.004255 | 34 |
| 2.Monopoly of material by some suppliers | 0.004198 | 35 |
| 16.High rate of interest | 0.004188 | 36 |
| 26.No practical use of earned value management system | 0.004158 | 37 |
| 32.Stoppages because of work being rejected by consultant | 0.004012 | 38 |
| 4.Types of material availability at local market | 0.003987 | 39 |
| 3.Prices fluctuation | 0.003759 | 40 |
| 5.Lack of consultant’s knowledge of available materials | 0.003729 | 41 |
| 43.Accidents during construction | 0.003614 | 42 |
| 18.Increase in salaries of skilled laborers | 0.003012 | 43 |
| 42.Weather conditions | 0.002974 | 44 |

Table 5

Ranking of attributes for Abu Dhabi based on Severity index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Severity Index | Rank |
| 39.Changes in client requirements | 0.871795 | 1 |
| 40.Frequency of variation orders and additional works | 0.871795 | 2 |
| 38.Scope and specification changes | 0.85641 | 3 |
| 30.Delays in decisions making by the approval authorities | 0.846154 | 4 |
| 12.Construction cost underestimation | 0.830769 | 5 |
| 14.Delayed payment for completed work | 0.810256 | 6 |
| 15.Cash flow problem during construction | 0.8 | 7 |
| 44.Delay in getting NOCs from different government authorities | 0.794872 | 8 |
| 10.Unavailability of equipment | 0.789744 | 9 |
| 13.Poor site management | 0.779487 | 10 |
| 28.Poor communication between client, consultant and contractor | 0.779487 | 11 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.769231 | 12 |
| 37.Extension of time with cost claims | 0.769231 | 13 |
| 22.Delay in preparation and approval of drawing | 0.764103 | 14 |
| 8.Shortage of laborers | 0.748718 | 15 |
| 6.Low productivity | 0.74359 | 16 |
| 7.Poor work execution | 0.74359 | 17 |
| 19.Change design | 0.733333 | 18 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.728205 | 19 |
| 36.Underestimation of time for completion of project | 0.728205 | 20 |
| 17.Contractor’s financial difficulties | 0.723077 | 21 |
| 11.Lack of engineering experience | 0.717949 | 22 |
| 23.Inaccurate quantity take-off | 0.717949 | 23 |
| 31.Change schedule | 0.717949 | 24 |
| 41.Rework due to error in execution | 0.712821 | 25 |
| 9.Mistakes happens during construction phase | 0.707692 | 26 |
| 20.Errors and omission in design | 0.707692 | 27 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.707692 | 28 |
| 33.Lowest bid price | 0.705263 | 29 |
| 34.Insufficient time for preparation of contract documents | 0.697436 | 30 |
| 24.Long period from planning of project to construction | 0.687179 | 31 |
| 16.High rate of interest | 0.682051 | 32 |
| 35.Discrepancies in contract documents | 0.671795 | 33 |
| 26.No practical use of earned value management system | 0.661538 | 34 |
| 25.Delays in issuing information to the contractor during construction stage | 0.641026 | 35 |
| 1.Delay in delivering material to construction site | 0.630769 | 36 |
| 32.Stoppages because of work being rejected by consultant | 0.605128 | 37 |
| 18.Increase in salaries of skilled laborers | 0.6 | 38 |
| 4.Types of material availability at local market | 0.564103 | 39 |
| 5.Lack of consultant’s knowledge of available materials | 0.564103 | 40 |
| 2.Monopoly of material by some suppliers | 0.533333 | 41 |
| 43.Accidents during construction | 0.523077 | 42 |
| 3.Prices fluctuation | 0.482051 | 43 |
| 42.Weather conditions | 0.471795 | 44 |

Table 6

Ranking of attributes for Dubai based on Severity index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Severity Index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.8 | 1 |
| 39.Changes in client requirements | 0.795349 | 2 |
| 13.Poor site management | 0.772093 | 3 |
| 36.Underestimation of time for completion of project | 0.75814 | 4 |
| 12.Construction cost underestimation | 0.753488 | 5 |
| 38.Scope and specification changes | 0.753488 | 6 |
| 11.Lack of engineering experience | 0.748837 | 7 |
| 37.Extension of time with cost claims | 0.734884 | 8 |
| 41.Rework due to error in execution | 0.734884 | 9 |
| 7.Poor work execution | 0.725581 | 10 |
| 24.Long period from planning of project to construction | 0.716279 | 11 |
| 40.Frequency of variation orders and additional works | 0.716279 | 12 |
| 44.Delay in getting NOCs from different government authorities | 0.716279 | 13 |
| 19.Change design | 0.706977 | 14 |
| 23.Inaccurate quantity take-off | 0.702326 | 15 |
| 33.Lowest bid price | 0.683721 | 16 |
| 6.Low productivity | 0.67907 | 17 |
| 22.Delay in preparation and approval of drawing | 0.665116 | 18 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.665116 | 19 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.660465 | 20 |
| 35.Discrepancies in contract documents | 0.660465 | 21 |
| 14.Delayed payment for completed work | 0.655814 | 22 |
| 17.Contractor’s financial difficulties | 0.651163 | 23 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.646512 | 24 |
| 8.Shortage of laborers | 0.64186 | 25 |
| 1.Delay in delivering material to construction site | 0.637209 | 26 |
| 9.Mistakes happens during construction phase | 0.637209 | 27 |
| 25.Delays in issuing information to the contractor during construction stage | 0.637209 | 28 |
| 15.Cash flow problem during construction | 0.627907 | 29 |
| 2.Monopoly of material by some suppliers | 0.618605 | 30 |
| 34.Insufficient time for preparation of contract documents | 0.618605 | 31 |
| 31.Change schedule | 0.609302 | 32 |
| 10.Unavailability of equipment | 0.6 | 33 |
| 4.Types of material availability at local market | 0.590698 | 34 |
| 20.Errors and omission in design | 0.590698 | 35 |
| 43.Accidents during construction | 0.581395 | 36 |
| 16.High rate of interest | 0.576744 | 37 |
| 26.No practical use of earned value management system | 0.576744 | 38 |
| 28.Poor communication between client, consultant and contractor | 0.572093 | 39 |
| 32.Stoppages because of work being rejected by consultant | 0.572093 | 40 |
| 5.Lack of consultant’s knowledge of available materials | 0.548837 | 41 |
| 3.Prices fluctuation | 0.525581 | 42 |
| 18.Increase in salaries of skilled laborers | 0.516279 | 43 |
| 42.Weather conditions | 0.488372 | 44 |

Table 7

Ranking of attributes for Sharjah based on Severity index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Severity  Index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.8 | 1 |
| 39.Changes in client requirements | 0.795349 | 2 |
| 13.Poor site management | 0.772093 | 3 |
| 36.Underestimation of time for completion of project | 0.75814 | 4 |
| 12.Construction cost underestimation | 0.753488 | 5 |
| 38.Scope and specification changes | 0.753488 | 6 |
| 11.Lack of engineering experience | 0.748837 | 7 |
| 37.Extension of time with cost claims | 0.734884 | 8 |
| 41.Rework due to error in execution | 0.734884 | 9 |
| 7.Poor work execution | 0.725581 | 10 |
| 24.Long period from planning of project to construction | 0.716279 | 11 |
| 40.Frequency of variation orders and additional works | 0.716279 | 12 |
| 44.Delay in getting NOCs from different government authorities | 0.716279 | 13 |
| 19.Change design | 0.706977 | 14 |
| 23.Inaccurate quantity take-off | 0.702326 | 15 |
| 33.Lowest bid price | 0.683721 | 16 |
| 6.Low productivity | 0.67907 | 17 |
| 22.Delay in preparation and approval of drawing | 0.665116 | 18 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.665116 | 19 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.660465 | 20 |
| 35.Discrepancies in contract documents | 0.660465 | 21 |
| 14.Delayed payment for completed work | 0.655814 | 22 |
| 17.Contractor’s financial difficulties | 0.651163 | 23 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.646512 | 24 |
| 8.Shortage of laborers | 0.64186 | 25 |
| 1.Delay in delivering material to construction site | 0.637209 | 26 |
| 9.Mistakes happens during construction phase | 0.637209 | 27 |
| 25.Delays in issuing information to the contractor during construction stage | 0.637209 | 28 |
| 15.Cash flow problem during construction | 0.627907 | 29 |
| 2.Monopoly of material by some suppliers | 0.618605 | 30 |
| 34.Insufficient time for preparation of contract documents | 0.618605 | 31 |
| 31.Change schedule | 0.609302 | 32 |
| 10.Unavailability of equipment | 0.6 | 33 |
| 4.Types of material availability at local market | 0.590698 | 34 |
| 20.Errors and omission in design | 0.590698 | 35 |
| 43.Accidents during construction | 0.581395 | 36 |
| 16.High rate of interest | 0.576744 | 37 |
| 26.No practical use of earned value management system | 0.576744 | 38 |
| 28.Poor communication between client, consultant and contractor | 0.572093 | 39 |
| 32.Stoppages because of work being rejected by consultant | 0.572093 | 40 |
| 5.Lack of consultant’s knowledge of available materials | 0.548837 | 41 |
| 3.Prices fluctuation | 0.525581 | 42 |
| 18.Increase in salaries of skilled laborers | 0.516279 | 43 |
| 42.Weather conditions | 0.488372 | 44 |

Table 8

Ranking of attributes for Abu Dhabi based on Frequency index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Frequency Index | Rank |
| 40.Frequency of variation orders and additional works | 0.92 | 1 |
| 44.Delay in getting NOCs from different government authorities | 0.913462 | 2 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.885417 | 3 |
| 30.Delays in decisions making by the approval authorities | 0.875 | 4 |
| 28.Poor communication between client, consultant and contractor | 0.869565 | 5 |
| 39.Changes in client requirements | 0.868421 | 6 |
| 38.Scope and specification changes | 0.865385 | 7 |
| 22.Delay in preparation and approval of drawing | 0.859375 | 8 |
| 7.Poor work execution | 0.85 | 9 |
| 31.Change schedule | 0.848485 | 10 |
| 20.Errors and omission in design | 0.846774 | 11 |
| 37.Extension of time with cost claims | 0.844828 | 12 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.828571 | 13 |
| 23.Inaccurate quantity take-off | 0.798387 | 14 |
| 36.Underestimation of time for completion of project | 0.794643 | 15 |
| 6.Low productivity | 0.790323 | 16 |
| 25.Delays in issuing information to the contractor during construction stage | 0.782258 | 17 |
| 15.Cash flow problem during construction | 0.78 | 18 |
| 19.Change design | 0.778846 | 19 |
| 24.Long period from planning of project to construction | 0.777778 | 20 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.77 | 21 |
| 14.Delayed payment for completed work | 0.763158 | 22 |
| 35.Discrepancies in contract documents | 0.757813 | 23 |
| 10.Unavailability of equipment | 0.75 | 24 |
| 26.No practical use of earned value management system | 0.742857 | 25 |
| 41.Rework due to error in execution | 0.742424 | 26 |
| 11.Lack of engineering experience | 0.741667 | 27 |
| 32.Stoppages because of work being rejected by consultant | 0.729167 | 28 |
| 12.Construction cost underestimation | 0.714286 | 29 |
| 8.Shortage of laborers | 0.709677 | 30 |
| 34.Insufficient time for preparation of contract documents | 0.708333 | 31 |
| 18.Increase in salaries of skilled laborers | 0.702703 | 32 |
| 17.Contractor’s financial difficulties | 0.684783 | 33 |
| 4.Types of material availability at local market | 0.669118 | 34 |
| 9.Mistakes happens during construction phase | 0.666667 | 35 |
| 33.Lowest bid price | 0.663462 | 36 |
| 16.High rate of interest | 0.657143 | 37 |
| 1.Delay in delivering material to construction site | 0.637097 | 38 |
| 5.Lack of consultant’s knowledge of available materials | 0.632353 | 39 |
| 3.Prices fluctuation | 0.628378 | 40 |
| 43.Accidents during construction | 0.621429 | 41 |
| 42.Weather conditions | 0.590278 | 42 |
| 13.Poor site management | 0.583333 | 43 |
| 2.Monopoly of material by some suppliers | 0.544118 | 44 |

Table 9

Ranking of attributes for Dubai based on Frequency index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Frequency Index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.9 | 1 |
| 37.Extension of time with cost claims | 0.878378 | 2 |
| 38.Scope and specification changes | 0.871622 | 3 |
| 39.Changes in client requirements | 0.870968 | 4 |
| 13.Poor site management | 0.852941 | 5 |
| 36.Underestimation of time for completion of project | 0.844595 | 6 |
| 6.Low productivity | 0.839286 | 7 |
| 7.Poor work execution | 0.835526 | 8 |
| 11.Lack of engineering experience | 0.830645 | 9 |
| 22.Delay in preparation and approval of drawing | 0.826923 | 10 |
| 44.Delay in getting NOCs from different government authorities | 0.806452 | 11 |
| 19.Change design | 0.805556 | 12 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.797297 | 13 |
| 41.Rework due to error in execution | 0.795455 | 14 |
| 17.Contractor’s financial difficulties | 0.792857 | 15 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.790698 | 16 |
| 40.Frequency of variation orders and additional works | 0.789063 | 17 |
| 15.Cash flow problem during construction | 0.782051 | 18 |
| 35.Discrepancies in contract documents | 0.78125 | 19 |
| 31.Change schedule | 0.779762 | 20 |
| 14.Delayed payment for completed work | 0.778571 | 21 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.771429 | 22 |
| 25.Delays in issuing information to the contractor during construction stage | 0.76875 | 23 |
| 12.Construction cost underestimation | 0.76 | 24 |
| 23.Inaccurate quantity take-off | 0.756944 | 25 |
| 20.Errors and omission in design | 0.75 | 26 |
| 28.Poor communication between client, consultant and contractor | 0.74375 | 27 |
| 10.Unavailability of equipment | 0.738372 | 28 |
| 8.Shortage of laborers | 0.737805 | 29 |
| 16.High rate of interest | 0.72619 | 30 |
| 26.No practical use of earned value management system | 0.72093 | 31 |
| 24.Long period from planning of project to construction | 0.720588 | 32 |
| 33.Lowest bid price | 0.717742 | 33 |
| 3.Prices fluctuation | 0.715116 | 34 |
| 34.Insufficient time for preparation of contract documents | 0.710526 | 35 |
| 32.Stoppages because of work being rejected by consultant | 0.70122 | 36 |
| 9.Mistakes happens during construction phase | 0.690789 | 37 |
| 1.Delay in delivering material to construction site | 0.689189 | 38 |
| 5.Lack of consultant’s knowledge of available materials | 0.679487 | 39 |
| 2.Monopoly of material by some suppliers | 0.678571 | 40 |
| 4.Types of material availability at local market | 0.675 | 41 |
| 43.Accidents during construction | 0.621622 | 42 |
| 42.Weather conditions | 0.608974 | 43 |
| 18.Increase in salaries of skilled laborers | 0.583333 | 44 |

Table 10

Ranking of attributes for Sharjah based on Frequency index

|  |  |  |
| --- | --- | --- |
| Attributes causing delay | Frequency Index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.9 | 1 |
| 37.Extension of time with cost claims | 0.878378 | 2 |
| 38.Scope and specification changes | 0.871622 | 3 |
| 39.Changes in client requirements | 0.870968 | 4 |
| 13.Poor site management | 0.852941 | 5 |
| 36.Underestimation of time for completion of project | 0.844595 | 6 |
| 6.Low productivity | 0.839286 | 7 |
| 7.Poor work execution | 0.835526 | 8 |
| 11.Lack of engineering experience | 0.830645 | 9 |
| 22.Delay in preparation and approval of drawing | 0.826923 | 10 |
| 44.Delay in getting NOCs from different government authorities | 0.806452 | 11 |
| 19.Change design | 0.805556 | 12 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.797297 | 13 |
| 41.Rework due to error in execution | 0.795455 | 14 |
| 17.Contractor’s financial difficulties | 0.792857 | 15 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.790698 | 16 |
| 40.Frequency of variation orders and additional works | 0.789063 | 17 |
| 15.Cash flow problem during construction | 0.782051 | 18 |
| 35.Discrepancies in contract documents | 0.78125 | 19 |
| 31.Change schedule | 0.779762 | 20 |
| 14.Delayed payment for completed work | 0.778571 | 21 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.771429 | 22 |
| 25.Delays in issuing information to the contractor during construction stage | 0.76875 | 23 |
| 12.Construction cost underestimation | 0.76 | 24 |
| 23.Inaccurate quantity take-off | 0.756944 | 25 |
| 20.Errors and omission in design | 0.75 | 26 |
| 28.Poor communication between client, consultant and contractor | 0.74375 | 27 |
| 10.Unavailability of equipment | 0.738372 | 28 |
| 8.Shortage of laborers | 0.737805 | 29 |
| 16.High rate of interest | 0.72619 | 30 |
| 26.No practical use of earned value management system | 0.72093 | 31 |
| 24.Long period from planning of project to construction | 0.720588 | 32 |
| 33.Lowest bid price | 0.717742 | 33 |
| 3.Prices fluctuation | 0.715116 | 34 |
| 34.Insufficient time for preparation of contract documents | 0.710526 | 35 |
| 32.Stoppages because of work being rejected by consultant | 0.70122 | 36 |
| 9.Mistakes happens during construction phase | 0.690789 | 37 |
| 1.Delay in delivering material to construction site | 0.689189 | 38 |
| 5.Lack of consultant’s knowledge of available materials | 0.679487 | 39 |
| 2.Monopoly of material by some suppliers | 0.678571 | 40 |
| 4.Types of material availability at local market | 0.675 | 41 |
| 43.Accidents during construction | 0.621622 | 42 |
| 42.Weather conditions | 0.608974 | 43 |
| 18.Increase in salaries of skilled laborers | 0.583333 | 44 |

Table 11

Ranking of attributes for Overall UAE on Frequency index

|  |  |  |
| --- | --- | --- |
| Attributes affecting delay | Frequency Index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.884831 | 1 |
| 40.Frequency of variation orders and additional works | 0.883333 | 2 |
| 38.Scope and specification changes | 0.872727 | 3 |
| 39.Changes in client requirements | 0.862637 | 4 |
| 37.Extension of time with cost claims | 0.858051 | 5 |
| 22.Delay in preparation and approval of drawing | 0.84322 | 6 |
| 19.Change design | 0.836634 | 7 |
| 36.Underestimation of time for completion of project | 0.832609 | 8 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.831858 | 9 |
| 44.Delay in getting NOCs from different government authorities | 0.82783 | 10 |
| 7.Poor work execution | 0.821429 | 11 |
| 20.Errors and omission in design | 0.816964 | 12 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.814904 | 13 |
| 6.Low productivity | 0.812992 | 14 |
| 15.Cash flow problem during construction | 0.8125 | 15 |
| 23.Inaccurate quantity take-off | 0.805804 | 16 |
| 31.Change schedule | 0.796512 | 17 |
| 14.Delayed payment for completed work | 0.786765 | 18 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.784884 | 19 |
| 25.Delays in issuing information to the contractor during construction stage | 0.782258 | 20 |
| 11.Lack of engineering experience | 0.776087 | 21 |
| 28.Poor communication between client, consultant and contractor | 0.774336 | 22 |
| 24.Long period from planning of project to construction | 0.770642 | 23 |
| 17.Contractor’s financial difficulties | 0.770619 | 24 |
| 12.Construction cost underestimation | 0.769444 | 25 |
| 35.Discrepancies in contract documents | 0.753846 | 26 |
| 32.Stoppages because of work being rejected by consultant | 0.751938 | 27 |
| 13.Poor site management | 0.75 | 28 |
| 41.Rework due to error in execution | 0.75 | 29 |
| 10.Unavailability of equipment | 0.746296 | 30 |
| 8.Shortage of laborers | 0.744048 | 31 |
| 26.No practical use of earned value management system | 0.740809 | 32 |
| 16.High rate of interest | 0.732955 | 33 |
| 34.Insufficient time for preparation of contract documents | 0.704 | 34 |
| 9.Mistakes happens during construction phase | 0.70082 | 35 |
| 3.Prices fluctuation | 0.69403 | 36 |
| 4.Types of material availability at local market | 0.692308 | 37 |
| 33.Lowest bid price | 0.685841 | 38 |
| 1.Delay in delivering material to construction site | 0.683468 | 39 |
| 18.Increase in salaries of skilled laborers | 0.672794 | 40 |
| 5.Lack of consultant’s knowledge of available materials | 0.655039 | 41 |
| 2.Monopoly of material by some suppliers | 0.636555 | 42 |
| 43.Accidents during construction | 0.612595 | 43 |
| 42.Weather conditions | 0.611111 | 44 |

Table 12

Ranking of attributes for Overall UAE on Severity Index

|  |  |  |
| --- | --- | --- |
| Attributes affecting delay | Severity Index | Rank |
| 39.Changes in client requirements | 0.813986 | 1 |
| 30.Delays in decisions making by the approval authorities | 0.805594 | 2 |
| 38.Scope and specification changes | 0.788811 | 3 |
| 40.Frequency of variation orders and additional works | 0.781818 | 4 |
| 19.Change design | 0.761151 | 5 |
| 12.Construction cost underestimation | 0.758042 | 6 |
| 13.Poor site management | 0.753846 | 7 |
| 36.Underestimation of time for completion of project | 0.732867 | 8 |
| 44.Delay in getting NOCs from different government authorities | 0.732867 | 9 |
| 37.Extension of time with cost claims | 0.73007 | 10 |
| 23.Inaccurate quantity take-off | 0.727273 | 11 |
| 15.Cash flow problem during construction | 0.725874 | 12 |
| 22.Delay in preparation and approval of drawing | 0.724476 | 13 |
| 14.Delayed payment for completed work | 0.721678 | 14 |
| 17.Contractor’s financial difficulties | 0.716084 | 15 |
| 41.Rework due to error in execution | 0.711888 | 16 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.709091 | 17 |
| 7.Poor work execution | 0.706294 | 18 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.703497 | 19 |
| 11.Lack of engineering experience | 0.702098 | 20 |
| 24.Long period from planning of project to construction | 0.696503 | 21 |
| 20.Errors and omission in design | 0.693706 | 22 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.692308 | 23 |
| 6.Low productivity | 0.690909 | 24 |
| 10.Unavailability of equipment | 0.683916 | 25 |
| 8.Shortage of laborers | 0.681119 | 26 |
| 9.Mistakes happens during construction phase | 0.665734 | 27 |
| 28.Poor communication between client, consultant and contractor | 0.664336 | 28 |
| 33.Lowest bid price | 0.656338 | 29 |
| 31.Change schedule | 0.655944 | 30 |
| 25.Delays in issuing information to the contractor during construction stage | 0.65035 | 31 |
| 35.Discrepancies in contract documents | 0.637762 | 32 |
| 34.Insufficient time for preparation of contract documents | 0.636364 | 33 |
| 16.High rate of interest | 0.633566 | 34 |
| 32.Stoppages because of work being rejected by consultant | 0.620979 | 35 |
| 1.Delay in delivering material to construction site | 0.615385 | 36 |
| 26.No practical use of earned value management system | 0.611189 | 37 |
| 2.Monopoly of material by some suppliers | 0.598601 | 38 |
| 4.Types of material availability at local market | 0.583217 | 39 |
| 5.Lack of consultant’s knowledge of available materials | 0.566434 | 40 |
| 18.Increase in salaries of skilled laborers | 0.551049 | 41 |
| 3.Prices fluctuation | 0.548252 | 42 |
| 43.Accidents during construction | 0.53986 | 43 |
| 42.Weather conditions | 0.497902 | 44 |

Table 13

Ranking of attributes for Overall UAE on Importance Index

|  |  |  |
| --- | --- | --- |
| Attributes affecting delay | Importance Index | Rank |
| 30.Delays in decisions making by the approval authorities | 0.007128 | 1 |
| 39.Changes in client requirements | 0.007022 | 2 |
| 40.Frequency of variation orders and additional works | 0.006906 | 3 |
| 38.Scope and specification changes | 0.006884 | 4 |
| 19.Change design | 0.006368 | 5 |
| 37.Extension of time with cost claims | 0.006264 | 6 |
| 22.Delay in preparation and approval of drawing | 0.006109 | 7 |
| 36.Underestimation of time for completion of project | 0.006102 | 8 |
| 44.Delay in getting NOCs from different government authorities | 0.006067 | 9 |
| 29.Insufficient coordination between local authority who is responsible about road projects and service authorities | 0.005899 | 10 |
| 15.Cash flow problem during construction | 0.005898 | 11 |
| 23.Inaccurate quantity take-off | 0.00586 | 12 |
| 12.Construction cost underestimation | 0.005833 | 13 |
| 7.Poor work execution | 0.005802 | 14 |
| 21.Incomplete design drawings and specifications at tendering stage | 0.005733 | 15 |
| 14.Delayed payment for completed work | 0.005678 | 16 |
| 20.Errors and omission in design | 0.005667 | 17 |
| 13.Poor site management | 0.005654 | 18 |
| 6.Low productivity | 0.005617 | 19 |
| 17.Contractor’s financial difficulties | 0.005518 | 20 |
| 11.Lack of engineering experience | 0.005449 | 21 |
| 27.Lack of cost planning/monitoring during pre and post contract stage | 0.005434 | 22 |
| 24.Long period from planning of project to construction | 0.005368 | 23 |
| 41.Rework due to error in execution | 0.005339 | 24 |
| 31.Change schedule | 0.005225 | 25 |
| 28.Poor communication between client, consultant and contractor | 0.005144 | 26 |
| 10.Unavailability of equipment | 0.005104 | 27 |
| 25.Delays in issuing information to the contractor during construction stage | 0.005087 | 28 |
| 8.Shortage of laborers | 0.005068 | 29 |
| 35.Discrepancies in contract documents | 0.004808 | 30 |
| 32.Stoppages because of work being rejected by consultant | 0.004669 | 31 |
| 9.Mistakes happens during construction phase | 0.004666 | 32 |
| 16.High rate of interest | 0.004644 | 33 |
| 26.No practical use of earned value management system | 0.004528 | 34 |
| 33.Lowest bid price | 0.004501 | 35 |
| 34.Insufficient time for preparation of contract documents | 0.00448 | 36 |
| 1.Delay in delivering material to construction site | 0.004206 | 37 |
| 4.Types of material availability at local market | 0.004038 | 38 |
| 2.Monopoly of material by some suppliers | 0.00381 | 39 |
| 3.Prices fluctuation | 0.003805 | 40 |
| 5.Lack of consultant’s knowledge of available materials | 0.00371 | 41 |
| 18.Increase in salaries of skilled laborers | 0.003707 | 42 |
| 43.Accidents during construction | 0.003307 | 43 |
| 42.Weather conditions | 0.003043 | 44 |

Table 14

Difference in Cost Overrun due to Frequency of attributes in Different States/Emirates.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **States/Emirates** | | | | | |
| **Cost Overrun** | | Abu Dhabi | | Dubai | | Sharjah |
| Often | | 28.76% | | 31.50% | | 39.72% |
| Rarely | | 27.69% | | 26.15% | | 46.15% |
| Never | | 0% | | 60.00% | | 40.00% |
|  | | **Cost Overrun** | | | | |
| **States/Emirates** | | Often | Rarely | | Never | |
| Abu Dhabi | | 53.84% | 46.15% | | 0% | |
| Dubai | | 62.79% | 39.53% | | 6.92% | |
| Sharjah | | 49.10% | 47.58% | | 3.3% | |

Table 15

Difference in Cost Overrun due to Severity of attributes in Different States/Emirates.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Cost Overrun** | | |
| **States/Emirates** | Often | Rarely | Never |
| Abu Dhabi | 53.84% | 46.15% | 0% |
| Dubai | 62.79% | 39.53% | 6.82% |
| Sharjah | 49.10% | 47.50% | 2.9% |

**Conclusion**

This research reveals that of the 44 factors the following factors affect the most in road project delays:

1. Delays in decisions making by the approval authorities
2. Changes in client requirements
3. Frequency of variation orders and additional works
4. Scope and specification changes
5. Change design
6. Extension of time with cost claims
7. Delay in preparation and approval of drawing
8. Underestimation of time for completion of project
9. Delay in getting NOCs from different government authorities
10. Construction cost underestimation
11. Poor site management
12. Delayed payment for completed work

Analyzing the Cost Overrun in road projects reveals that of the three states/emirates, Dubai is most and Sharjah is least probable to Cost Overrun. But it is also seen that there is not much difference in the percentage of occurrence of Cost Overrun in the three states/emirates.

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