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ANALYSIS OF CONSTRUCTION DELAY CAUSES IN DAMS PROJECTS IN OMAN

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ABSTRACT

Delays in Dam construction projects are one of the biggest challenges in recent years. There are many causes behind these delays, which in turn affects the project performance at large in the overall world, including Oman. This research aimed to investigate and analyse the causes of delays in Dam projects in Oman. An intensive literature review was carried out to identify the causes of delays in Dam and infrastructure projects. Then, a questionnaire survey was employed to collect data from professionals involved in Dam construction projects. 60 causes of delay were integrated in the questionnaires which were grouped under four main categories: Client, Contractor, Consultant and External Factors. The collected data was then analysed statistically and ranked according to its significance. The results reveal, based on Pareto's law of 80/20, that the top causes behind the delays of Dam construction projects in Oman are: severe weather conditions, change orders, uncertainty in ground condition, poor site management, executive bureaucracy in client organization, feasibility study did not cover all aspects, mistakes in soil investigation, natural effects during construction work, difficulty of defining project requirement, slowness of decision making process, delay of obtaining approval from the different government authorities, and land acquisition. These findings demonstrate there is an urgent necessity to tackle the project's site related causes, and causes related to client and contractor.

Key words: Causes of delay, Construction projects, Dam Projects, Oman

1. Introduction

Construction projects in general are complex, especially during construction stage. Dam projects in Oman are not an exception. They are subject to delays and cost overruns. Construction delays occur due to many causes. Dam projects in Oman were subject to severe delays which in turn delayed their operation and benefits. This was because of many controllable and uncontrollable causes. Oman is a developing country in which the construction industry is one of promising sector and contributes more than 5.4% in GDP (Ministry of National Economy, 2010). Rapidly the construction industry grows in construction buildings, roads, airports, seaports, Dams projects, and other infrastructure construction projects. During 2013, there was a huge amount of government expenditure on infrastructure projects with an amount of 3.967 Billion USD. This is a clear indication of the direction of government to invest in local infrastructure. On the other hand, over the years, the government has suffered from delays in Dams projects because of disabilities in the conduct of the government's plan. This phenomenon is seemingly annually increasing and the negative impact and consequences have created a disturbance in the fifth planning period of 2015-2020, as well as negatively affecting the end user of the project through wasted time and a frustration of productivity. Also, the delays of major projects such as Dams lead to delays in the government strategic plan and put pressure on the government to incur additional charges that were not taken into account to adjust the situation. The government is continuously encouraging the construction sector in Oman through providing the facilities to the contractors, as well as being a major client of infrastructure projects (Ministry of National Economy, 2015).

In the Omani context, there are various causes of delay in public projects; some of them are controllable and the others are uncontrollable, such as weather conditions, order variation and claims (Alnuaimi and AlMohsin, 2013). Since the quantity of water resources in Sultanate of Oman is limited, the government planned to develop the water sector through constructing recharge Dams and small storage Dams. If a delay occurs, then it will negatively influence the government infrastructure development and also badly affect the community benefits.

Around the world, there are a considerable number of studies that have investigated the delay in construction projects in general. For example, Enshassi et al (2009) reported that the causes of delay in Gaza strip in construction projects were lack of materials, shortage of highly experienced and qualified staff, poor quality of equipment, lack of raw materials and shortage of skilled leadership managers in a project. Other researchers in the Malaysian construction industry identified the lack of labourers, improper planning from contractors, poor site management from contractors, lack of experience in contractors, lack of funds from the clients, disputes with sub-contractors, poor communication among all parties and errors during construction work (Samasivan and Soon 2007) as causes of delays. In Oman, a study by Alnuaimi and AlMohsin (2013), clarified various causes that lead to delays in public sector projects such as new rules and regulations, weather conditions, variation in orders and claims, changes in design, and condition of ground.

Most of the researchers identified the causes of delays in the construction industry such as buildings projects and road projects, but limited study were done in Dam projects because of either the unavailability of data or they were classified as complicated projects. Actually, in Oman, there is no specific research on delays at Dam projects, only as case studies in general for public construction projects delays, as well as delays in other sectors such as Oil & Gas. The construction projects are almost similar in causes of delay but there are differences in the nature of projects and their contexts. In the Sultanate of Oman, the delays in Dams projects increase annually, so the attempt of this study is to understand the root of the causes of delay and

categorize them in order to set appropriate solutions and to inspire the delivery of Dam projects without delays to contribute to the achievement of the construction industry and the future vision 2040 in Sultanate of Oman. In order to tackle these problems, it is necessary to identify the causes of delay in Dam construction projects in Oman. Therefore, there is a real need to deeply investigate these causes and produce a set of solutions or recommendations to tackle these causes and reduce their negative impacts on achieving project objectives.

2. Aim of the Study:

The main aim of this study is to investigate and analyse the significant causes that lead to construction delay in Dams construction projects in Oman. The aim of this paper was achieved through the following sections, starting with the literature review, research methodology, data collection and analysis, results discussion, conclusions and set of recommendations.

3. Literature review:

The delay terminology in construction projects has been defined by several authors. Assaf and Al-Hejji (2006) defined delay as the time consumed beyond the specified duration in the project contract agreement. It can be recognised that delay means the time required to complete the project beyond the agreed contract period. Therefore, it can be stated that successful projects are those projects that are completed on time, within budget and with respect to the specification standards in the contract document. In this research, delays in Dam construction projects will be considered as the requested additional time to complete the project beyond the original period of contract or, in other words, it is the amount of difference between the planned construction time for the project and the actual time to complete it.

Delay types in construction projects can be classified in several ways. For example, Yates and Epstein (2006) categorized them into five groups as follows: Non-Compensable Excusable Construction Delays, Compensable Excusable Construction Delays, Non-Excusable Construction Delay, Concurrent Construction Delays, and Critical and Noncritical Construction Delays. However, in order to classify the causes under these categories, this requires deep analysis and investigation and also agreement by various project parties.

In the construction industry, delay is as a major problem that faces projects in being completed as required. The main source of construction delays comes from project stakeholders such as clients, consultants and contractors (Niazai and Gidado, 2012). Various causes of delays in construction projects are classified under these three main parties.

The first group of delay causes is related to the Client. For example, Alinaitwe et al (2013) found that the scope of work change and delays of payment to contractors were causes of delay in a construction project in the public sector in Uganda. In a similar way, James et al (2014) found that frequent changes of drawings, delays in decision-making, and variations in orders were the most significant causes of delays in Nigerian construction projects. Alnuaimi and AlMohsin (2013) identified several causes leading to delays in construction projects in the public sector in Oman as variation orders, changes in design, disputes between client and contractor, and lack of experience of sub-contractors which were nominated by the client. From my perspective, today, in construction projects most of delay causes are related to clients because of an increase of variation in orders, frequent changes in design, ability of clients to finance the project, and lack of experience of the client leading to rising disputes with contractors.

The second group of delay causes is related to the Consultant. For example, Al Hadi et al (2009) stated that design errors and lack of effective communication between project parties were the main causes affecting

the time overrun in a construction project in Libya. The errors in bill of quantity estimation and delays in providing designs from the consultant gave rise to the late completion of the Dam project in Rwanda (Gasasira et al, 2016). Furthermore, Alnuaimi and AlMohsin (2013) argued that the consultant should have a great deal of experience and be able to effectively communicate with other project parties; this is a key factor in avoiding disputes and time overrun in construction projects in the public sector in Oman. Atout (2013) explained the important causes that led to delays in construction projects in the United Arab Emirates (UAE) from the consultant's side were very poor designs, incomplete and insufficient drawings, lack of approval submittals, lack of inspection procedures, and a lack of response to any technical inquiries. Most delay causes in pre-construction phases of the project take under the consultants' responsibilities in case of direct effect such as delay in providing design and design errors, and indirect causes such as lack of effective communication between all parties of the project and lack of response to any technical issue.

The third group of causes of delays is related to the contractor. Several studies were conducted to identify the causes of delay in the construction industry and found causes which are related to contractor. For example, Enshassi et al (2009) determined the causes of delays in construction project in Gaza Strip, which were the availability of resources needed for the construction project such as staff with high experience and qualifications, lack of construction materials, and lack of excellent equipment. AlHadi et al (2009) did a survey in the Libyan construction industry to assess the potential causes leading to delay. He found improper planning from contractors and a shortage of materials on site are the most significant causes of delay. Gasasira et al, (2016) recognised that the lack of soil investigation during the design stage in the Dam project in Rwanda led to working beyond the scheduled time during the construction phase. According to Assaf and Al-Hejji (2006), who carried out research in a construction project in Saudi Arabia, it was found that ineffective planning and scheduling by the contractor and poor site management and supervision were the main causes behind the delay issue. Pourrostam and Ismail (2012) carried out research to find out the main causes leading to delays in the Iranian construction projects. Several causes were identified according to various project parties; for example, the causes related to the contractor were poor site management, financial difficulties, and ineffective planning and scheduling of the project. Furthermore, Alnuaimi and AlMohsin (2013) mentioned that the lack of experience for contractors is the main factor in avoiding disputes and overrunning time in construction projects in the public sector in Oman. Haseeb et al (2011) studied the causes of delay in the large construction industry in Pakistan. They found that the most important causes related to the contractor are poor estimation of the construction work, delay in payment to the sub-contractor from the contractor, poor site management, the use of old equipment, and a shortage of materials on site. Additionally, successful contractors who are able to manage all various resources, such as human, financial, and materials, are needed to efficiently maintain the construction processes. The significant causes of delay from the contractor side are mainly concerned with insufficient resources, poor site management and supervision, and disputes with client and consultant.

The causes of delay in construction projects differ in grouping from author to author. The common classifications of delay causes in construction were determined by Fugar and Agyakwah-Baah (2010). They classified them into nine groups: financing, government action, scheduling and controlling techniques, materials, equipment, contractual relationships, changes, environment and manpower. Also, Assaf and Al-Hejji (2006) conducted a study on construction projects in Saudi Arabia and determined nine groups of delay causes that include the three main project parties, labour-related causes, project-related causes, plan/equipment-related causes, design team-related causes, materials-related causes, and external causes.

The construction industry is a project-based industry which significantly contributes to the development of

an economy in any country. Therefore, delays in construction projects are majorly harmful to all stakeholders involved in the project. According to Sambasivam and Soon (2007), there are six major effects of delays involving time overrun, cost overrun, dispute, arbitration, total abandonment and litigation. In addition, Divya and Ramya (2015) mentioned two additional effects that are poor quality in the completion of the projects and bad public relations. However, the top two important effects of delay are time and cost overrun.

Delays in Dam construction projects started to receive a great deal of attention because of the complexity of the project from design and implementation (Gasasira et al, 2016). Thus, limited research has been studying this phenomenon, especially in developing countries. However, most projects are rarely completed within the original scheduled time because it requires effective and efficient management. Therefore, the reason behind time delays might be controllable or uncontrollable. Gasasira et al (2016) presented the causes leading to delays in Dam construction projects in Rwanda and found the major causes were slowness in making decisions from the clients, lack of an appropriate management schedule, defaults in cost estimation from the contractor, inadequate contract management, poor provision of and delay in designs, errors in estimation and lack of soil investigation by consultants, and land acquisition problems. These causes were found as a result of the survey. However, geographical location also affects developing countries because of their size, which increases the degree of exposure to ecological risks, especially with regard to adverse weather conditions. The significant causes of delay during construction of Dam project in Nepal were identified as ecological conflict which led to delay the project progress and weakened the ability to complete the project on time.

The Sultanate of Oman is one of the developing countries in the Gulf Cooperation Council (GCC) with a rapid growth of infrastructure construction projects and has annually spent a huge amount of resources and money to develop the construction industry in all governesses in Oman. Infrastructure construction projects, such as airports, roads, oil and gas, and Dams, are subjected to many challenges and obstacles that lead to delays. In addition, during the current period, Oman and other GCC countries are currently suffering from the sharp economic recession that started in mid-2014, because the entirety of the GCC states' GDP depends on oil income. The oil price decreased to less than $40/Barrel therefore has lost more than 60% of its previous value. Therefore, the construction projects have been delayed, with one of the main causes of delay being government (Client) payment taking longer than six months (James, 2016). Construction of Dams requires several specialist engineers, such as hydrological, geological, mechanical, architectural, electrical, environmental, and construction, to collaborate with each other to accomplish different objectives of the project. There were several studies conducted about Dam projects for example, in a study conducted in Nepal by Mahato and Ogunlana (2011), they found causes of delays such as interruptions of work, expenses of additional work and weather effects were the main causes of delay. However, there are no studies regarding this type of project in Oman. In this study, it can be based on the statement of the Minister of Regional Municipalities and Water Resources in front of members of the Shura Council, which touched the reasons for delay in the implementation and completion of some projects of the ministry, were "*project modifications, frequent objections from local people, limited availability of the necessary expertise in specialized in the field of extensive market studies before embarking on a project assignment, overlapping implement more than one project per site and several government institutions by the private hindering, and delaying the adoption of the designs of these projects lead to the cancellation of the project or change its design"*(Alwatan Newspaper-Oman 2016).

4. Research Methodology and Data Collection :

Following the literature review and identification of causes of delay in construction projects in general and Dam projects in particular, a questionnaire survey was designed to collect data from construction professionals (i.e. Client, Consultant and Contractor) in Oman. The questionnaire was divided into two sections. Section one was related to the respondents' personal details, such as their qualifications and organisations. The second section focused on the causes of delays in Dam projects in Oman. The total of 60 causes were categorised into four groups including clients, consultants, contractors, and external causes. In section two, the respondent was asked to give his/her opinion on the frequency of occurrence for each cause and its possible impact based on a four point Likert scale as shown below. Also, the respondent was given the opportunity to add any cause which was not mentioned in the questionnaire. The questionnaire was distributed by using personal communication and email to 18 client representatives, 20 consultants, and 30 contractors and the total number of responses was 16, 16 and 20 respectively.

5. Causes of Delays in Dam Construction Project in Oman:

Through choosing an appropriate scale of questionnaire answers from respondents, and by ticking one, the occurrence and the impact degree of each cause of delay in Dam projects were listed in a questionnaire form. Several authors used the formula below, such as (Assaf et al, 2006; Falqi, 2006; Albogamy et al, 2013). Therefore, it can be used to rank the causes of delays in construction projects. The following details of the formula used:

5.1 Frequency Index (FI) = Σ [a. (n/N)] × 100/4

Where:

(a) Constant of weighting given to each response (1= Rarely, 2= Unlikely, 3= Possible and 4= Most likely).

(n) The frequency of responses.

(N) Total number of responses

5.2 Severity Index (SI) = Σ [a. (n/N)] × 100/4

Where:

(a) Constant weighting given to each response (1= No influence, 2= Fairly influence, 3= Medium and 4= Critical).

(n) The severity of responses.

(N) Total number of responses

5.3 Importance index (IMP.I) = (F.I x S.I) / 100

To calculate the importance index the formula used by Al Doy (2002)

Where:

(F.I) The calculated of frequency index.

(S.I) The calculated of severity index.

Table 1: presented all calculations of each cause of delay and average importance indices were ranked according to project parties (clients, consultants, and contractors). For example, Row 2 presents the delay in contractor's payment by client due to financial process cause; this cause category is under client related cause (Column 3). Moreover, the cause presented each respondents' indices (i.e. Column 4 represents client, Column 5 represents consultant and Column 6 represents contractor), which included the frequency, severity, and importance indices, as well as the overall rank according to the overall importance indices recorded from the highest value to the lowest value. Therefore, row 1 shows the client respondent as FI

(71.8), SI (71.8), and IMP.I (51.6), followed by consultant FI (56.2), SI (59.3), and IMP.I (33.3), and contractor FI (67), SI (61.2), and IMP.I (41), while the overall IMP.I with (42), which overall ranked 21st out of 60 causes of delay. Table 1 below illustrates the overall top 12 causes of delay in Dam projects in Oman as ranked by respondents highlighted in Yellow.

Table 1: Frequency, Severity, importance indices, and overall average of ranking causes of delay

Causes S/N	Description of Causes	Delay Group	Client			Consultant			Contractor			Overall (IMP.I)	Overall Ranking
			FI	SI	IMP.I	FI	SI	IMP.I	FI	SI	IMP.I		
1	Delays in contractor's payment by client due to financial process	Client	71.8	71.8	**51.6**	56.2	59.3	**33.3**	67	61.2	**41**	**42**	**21**
2	Financial difficulties from the client side	Client	60.9	70.3	**42.8**	57.8	57.8	**33.4**	56.7	55.7	**31.6**	**35.9**	**31**
3	Change orders	Client	79.69	78.13	**62.2**	87.5	79.6	**69.7**	86.2	87.5	**75.4**	**69.1**	**2**
4	Slowness of decision making process	Client	68.7	71.8	**49.4**	75	75	**56.2**	75	77.2	**57.9**	**54.5**	**10**
5	Client interference and poor communicate with other parties	Client	60.9	64	**39**	48.4	48.3	**23.4**	63.7	52.5	**33.4**	**31.9**	**36**
6	Conflicts in work schedules with contractors	Client	60.9	59.3	**36.1**	34.3	45.3	**15.5**	43.2	41	**17.7**	**23.1**	**56**
7	Late handover of site	Client	67.1	60.9	**40.9**	50	48.4	**24.2**	45.5	42	**19.1**	**28**	**47**
8	Unrealistic contract durations imposed by client.	Client	56.2	59.3	**33.3**	56.2	56.2	**31.6**	59	54.5	**32.1**	**32.3**	**33**
9	Lack of cooperation between contractor and consultant	Client	46.8	50	**23.4**	46.8	60.9	**28.5**	53.5	48.7	**26**	**26**	**53**
10	Difficulty of defining project requirement	Client	59.3	75	**44.5**	79.6	73.4	**58.5**	80.7	78.5	**63.3**	**55.4**	**9**
11	Executive bureaucracy in the client's organization	Client	70.3	75	**52.7**	78.1	71.8	**56.1**	77.2	84	**64.8**	**57.9**	**5**
12	Claim due to late compensation of land clients	Client	68.7	71.8	**49.4**	60.9	60.9	**37.1**	68.2	61.2	**41.8**	**42.7**	**19**
13	Design errors	Consultant	70.3	78.1	**54.9**	60.9	57.8	**35.2**	71.5	70.5	**50.4**	**46.8**	**16**
14	Poor inspection and testing procedures used in the project	Consultant	60.9	64.0	**39**	51.5	51.5	**26.5**	56.7	48.7	**27.6**	**31**	**38**
15	Inaccurate cost estimation	Consultant	62.5	71.8	**44.9**	60.9	57.8	**35.2**	62.5	58	**36.2**	**38.8**	**26**
16	Insufficient information and contract documents	Consultant	68.7	73.4	**50.4**	59.3	51.5	**30.6**	64.7	67.7	**43.8**	**41.6**	
17	Mistakes in soil investigation	Consultant	71.8	81.2	**58.3**	73.4	78.1	**57.3**	75	75	**56.25**	**57.3**	**7**
18	Lack of effective communication	Consultant	57.8	60.9	**35.2**	46.8	48.4	**22.7**	54.5	55.7	**30.3**	**29.4**	**44**
19	Lack of experience of the design team	Consultant	62.5	65.6	**41**	45.3	42.1	**19.1**	39.7	41	**16.2**	**25.4**	**54**
20	Late preparation of interim certificates	Consultant	57.8	60.9	**35.2**	53.1	46.8	**24.9**	62.5	59	**36.8**	**32.3**	**34**

21	**Complexity of project design**	**Consultant**	50	50	**25**	46.8	43.7	**20.5**	51.2	47.7	**24.4**	**23.3**	**55**
22	**Late approval of shop drawings and material samples**	**Consultant**	62.5	64	**40**	48.4	46.8	**22.7**	53.5	52.2	**27.9**	**30.2**	**41**
23	**Feasibility study did not cover all aspects**	**Consultant**	67.1	78.1	**52.4**	73.4	75	**55**	81.7	79.5	**64.9**	**57.5**	**6**
24	**Poor site management**	**Contractor**	73.4	79.6	**58.5**	79.6	78.1	**62.2**	77.2	69.2	**53.4**	**58**	**4**
25	**Lack of availability of equipment**	**Contractor**	73.4	75	**55**	62.5	65.6	**41**	59	56.7	**33.4**	**43.1**	**18**
26	**Lack of experience of contractor and sub-contractor**	**Contractor**	67.1	70.3	**47.2**	54.6	53.1	**29**	58	59	**34.2**	**36.8**	**30**
27	**Accidents during construction**	**Contractor**	67.1	64.0	**43**	45.3	46.8	**21.2**	45.5	45.5	**20.7**	**28.3**	**46**
28	**Unskilled operators such as plant drivers**	**Contractor**	60.9	60.9	**37.1**	45.3	48.4	**21.9**	44.2	44.2	**19.5**	**26.2**	**51**
29	**Contractor insolvency or financial difficulties in case of cash flow**	**Contractor**	67.1	76.5	**51.4**	56.2	56.2	**31.6**	61.2	68.2	**41.8**	**41.6**	**23**
30	**Mistakes during construction or defective work**	**Contractor**	73.4	71.8	**52.7**	70.3	68.7	**48.3**	63.7	64.7	**41.2**	**47.4**	**15**
31	**Improper planning of construction work**	**Contractor**	62.5	64.0	**40**	70.3	67.1	**47.2**	66.7	64.2	**42.8**	**43.3**	**17**
32	**Lack of monitoring**	**Contractor**	60.9	56.2	**34.2**	50	62.5	**31.2**	51.2	45.5	**23.3**	**29.6**	**43**
33	**Poor quality of materials provided**	**Contractor**	60.9	64	**39**	50	54.6	**27.3**	52.2	51.2	**26.7**	**31**	**39**
34	**Inappropriate/misuse of material**	**Contractor**	54.6	62.5	**34.1**	48.4	48.4	**23.4**	48.7	43.2	**21**	**26.2**	**50**
35	**Poor storage of material**	**Contractor**	60.9	65.6	**39.9**	42.1	42.1	**17.7**	34	34	**11.5**	**23.1**	**57**
36	**Shortage of skill workforce (Engineers, foremen and laborers)**	**Contractor**	62.5	71.8	**44.9**	54.6	57.8	**31.6**	58	64.7	**37.5**	**38**	**28**
37	**Poor controlling of subcontractors (payments, relationship)**	**Contractor**	68.7	71.8	**49.4**	46.8	60.9	**28.5**	60.2	63.7	**38.4**	**38.7**	**27**
38	**High number of contracts by same contractor (High workload)**	**Contractor**	60.9	59.3	**36.1**	46.8	46.8	**21.9**	52.2	41	**21.4**	**26.5**	**49**
39	**Act of God**	**External factor**	70.3	78.1	**54.9**	70.3	70.3	**49.4**	69.2	73.7	**51**	**51.8**	**13**
40	**Economic Problems (Downturn)**	**External factor**	62.5	70.3	**43.9**	59.3	62.5	**37.1**	59	62.5	**36.8**	**39.3**	**24**
41	**Employees turnover**	**External factor**	57.8	53.1	**30.7**	56.2	56.2	**31.6**	58	52.2	**30.3**	**30.8**	**40**
42	**External work around the site due to public agencies**	**External factor**	59.3	62.5	**37.1**	51.5	50	**25.7**	51.2	44.2	**22.6**	**28.5**	**46**
43	**Severe weather condition**	**External factor**	71.8	87.5	**62.8**	81.2	87.5	**71**	85.2	89.7	**76.5**	**70.1**	**1**
44	**Poor government judicial system for construction dispute settlement**	**External factor**	54.6	65.6	**35.8**	59.3	56.2	**33.3**	50	48.7	**24.3**	**31.2**	**37**
45	**Uncertainty in ground condition**	**External factor**	67.1	85.9	**57.7**	76.5	76.5	**58.6**	75	80.7	**60.5**	**58.9**	**3**
46	**Political instability**	**External factor**	46.8	56.2	**26.3**	39	43.7	**17**	31.7	31.7	**10**	**17.8**	**58**

47	Government policy and change in regulations	External factor	51.5	60.9	**31.4**	51.5	54.6	**28.1**	53.5	53.5	**28.6**	**29.4**	**45**
48	Delay of obtaining permit/approval from the different government authorities	External factor	68.7	76.5	**52.6**	75	71.8	**53.9**	69.2	80.7	**55.9**	**54.1**	**11**
49	Corruption	External factor	56.2	60.9	**34.2**	65.6	70.3	**46.1**	71.5	67	**47.9**	**42.7**	**20**
50	Delay of materials delivery	External factor	62.5	70.3	**43.9**	53.1	62.5	**33.2**	61.2	64.7	**39.6**	**38.9**	**25**
51	Unavailability of materials in the market	External factor	57.8	67.1	**38.8**	54.6	65.6	**35.8**	63.7	61.2	**39**	**37.9**	**29**
52	Increase of materials cost	External factor	60.9	62.5	**38**	60.9	57.8	**35.2**	58	54.7	**31.7**	**35**	**32**
53	Increase of equipment cost	External factor	57.8	64	**37**	53.1	56.2	**29.8**	55.7	53.5	**29.8**	**32.2**	**35**
54	Poor security	External factor	46.8	45.3	**21.2**	39	40.6	**15.8**	31.7	33	**10.4**	**15.8**	**60**
55	Procurement methods used	External factor	60.9	60.9	**37.1**	46.8	54.6	**25.6**	44.2	43.2	**19.1**	**27.3**	**48**
56	Fluctuation of prices/ Market inflation	External factor	59.3	60.9	**36.1**	45.3	51.5	**23.3**	42	45.5	**19.1**	**26.2**	**53**
57	Social and cultural factors	External factor	67.1	68.7	**46.1**	71.8	70.3	**50.5**	67	72.7	**48.7**	**48.4**	**14**
58	Natural effects during construction work	External factor	70.3	81.2	**57.1**	75	76.5	**57.4**	69.2	76.2	**52.8**	**55.7**	**8**
59	International border problems	External factor	45.3	45.3	**20.5**	42.1	45.3	**19.1**	33	30.7	**10.1**	**16.5**	**59**
60	Land acquisition	External factor	60.9	79.6	**48.5**	70.3	84.3	**59.3**	70.5	72.7	**51.2**	**53**	**12**

The causes were ranked and analysed based on the Pareto principle method. To determine the top causes in this research, the Pareto analysis was applied, which states that 20% of the input can l create a total of 80% of the result. In order, a majority of delays came from a minority of causes (Koch.R 1991). Figure 1 shows the Pareto Principle.

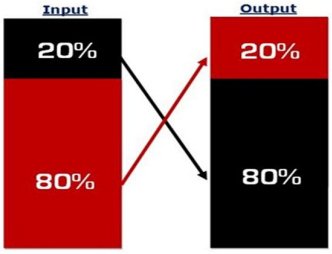

Figure 1: The Pareto Principle (80/20)
Adapted from: https://eazybi.com/blog/the_80_20_rule/

Through application of Pareto's principle (80%-20%), a total of 60 causes of delay was ranked, with the result to analyse and discuss the top 12th causes as illustrated in table 2. Moreover, the table shows other causes and how each of the project parties were ranked from the overall causes. The ranking process was done based on the result of respondents from the questionnaire and the priorities according to the highest to the smallest percentage of each causes of delay. The list of important causes of delay in Dam projects presented in table 4 was categorised into four responsibility groups as Client, consultant, contractor and external factor)

For example, table 2 illustrates that the severe weather condition caused by external factors in row (2) is in agreement as ranked by project parties in column 4, as well as in overall ranked are highlighted in Yellow. Similar rankings occurred for the change orders in row 2 as caused by client. Row 3 presents Uncertainty in ground condition overall ranked by respondents as third cause of delay (Column 5), while the client and consultants ranked as fifth (Column 4), but the contractor ranked as sixth cause (Column 4).

Table 2: Top 12 Causes of Delay in Dams Projects

Causes S/N	Description of Causes	Causes of delay Responsibility	Dam Projects Parties Ranked			Overall Ranking
			Client	Consultant	Contractor	
43	Severe weather condition	External Factor	1	1	1	1
3	Change orders	Client	2	2	2	2
45	Uncertainty in ground condition	External Factor	5	5	6	3
24	Poor site management	Contractor	3	3	10	4
11	Executive bureaucracy in the client's organization	Client	11	10	4	5
23	Feasibility study did not cover all aspects	Consultant	13	11	3	6
17	Mistakes in soil investigation	Consultant	4	8	8	7
58	Natural effects during construction work	External Factor	6	7	11	8
10	Difficulty of defining project requirement	Client	25	6	5	9
4	Slowness of decision making process	Client	17	9	7	10
48	Delay of obtaining permit/approval from the different government authorities	External Factor	12	12	9	11
60	Land acquisition	External Factor	20	4	12	12
39	Act of God	External Factor	9	14	13	13
57	Social and cultural factors	External Factor	22	13	15	14
30	Mistakes during construction	Contractor	10	15	21	15
13	Design errors	Consultant	8	22	14	16
31	Improper planning of construction work	Contractor	33	16	18	17
25	Lack of availability of equipment	Contractor	7	18	31	18
12	Claim due to late compensation of land clients	Client	18	19	19	19
49	Corruption	External Factor	51	17	16	20

6. Overall Top 12 causes of delay in Dam projects in Oman by project parties:

Table 3 illustrates the overall result of ranked causes of delay in Dam project in Oman by project parties which are severe weather conditions (**First**), change orders (**Second**), uncertainty in ground condition (**Third**), poor site management (**Fourth**), executive bureaucracy in the client's organization (**Fifth**), feasibility study did not cover all aspects (**Sixth**), mistakes in soil investigation (**Seventh**), natural effects during construction work (**Eighth**), difficulty of defining project requirement (**Ninth**), slowness of decision making process (**Tenth**), delay of obtaining permit/approval from the different government authorities (**Eleventh**), and land acquisition (**Twelfth**).

Table 3: Top Twelve Causes of Delay in Dams Projects

Causes S/N	Description of Causes	Delay Source	Dam Projects Parties Ranked			Average (IMP.I)	Overall Ranking
			Client	Consultant	Contractor		
43	Severe weather condition	External Factor	**62.8**	**71**	**76.5**	**70.1**	**1**
3	Change orders	Client	**62.2**	**69.7**	**75.4**	**69.1**	**2**
45	Uncertainty in ground condition	External Factor	**57.7**	**58.6**	**60.5**	**58.9**	**3**
24	Poor site management	Contractor	**58.5**	**62.2**	**53.4**	**58**	**4**
11	Executive bureaucracy in client organization	Client	**52.7**	**56.1**	**64.8**	**57.9**	**5**
23	Feasibility study did not cover all aspects	Consultant	**52.4**	**5**	**64.9**	**57.5**	**6**
17	Mistakes in soil investigation	Consultant	**58.3**	**57.3**	**56.2**	**57.3**	**7**
58	Natural effects during construction work	External Factor	**57.1**	**57.4**	**52.8**	**55.7**	**8**
10	Difficulty of defining project requirement	Client	**44.5**	**58.5**	**63.3**	**55.4**	**9**
4	Slowness of decision making process	Client	**49.4**	**56.2**	**57.9**	**54.5**	**10**
48	Delay of obtaining approval from the different government authorities	External Factor	**52.6**	**53.9**	**55.9**	**54.1**	**11**
60	Land acquisition	External Factor	**48.5**	**59.3**	**51.2**	**53.0**	**12**
39	Act of God	External Factor	54.9	49.4	51	51.8	13
57	Social and cultural factors	External Factor	46.1	50.5	48.7	48.4	14
30	Mistakes during construction or defective work	Contractor	52.7	48.3	41.2	47.4	15
13	Design errors	Consultant	54.9	35.2	50.4	46.8	16
31	Improper planning of construction work	Contractor	40	47.2	42.8	43.3	17
25	Lack of availability of equipment	Contractor	55	41	33.4	43.1	18
12	Claim due to late compensation of land clients	Client	49.4	37.1	41.8	42.7	19
49	Corruption	External Factor	34.2	46.1	47.9	42.7	20

Also from table 4, the causes of delay categories were based on different groups (Responsibilities) of delay causes in Dam projects. Additionally, in general all project parties agreed on the top two causes as severe weather condition (First) and change orders (Second). Overall, the top twelve important causes of delay were explained related to their responsibilities. The following discussion categories and illustrated causes of delay as per the project parties (clients, consultants, contractors) and external factors related.

Table 4: Proportion of sources causing Top 12 Delays in Dams Projects

Clients related causes	Consultants related causes	Contractors related causes	External Factors related causes	Total of Causes
4	2	1	5	12
33.3% (Second)	16.7% (Third)	8.3% (Fourth)	41.7% (First)	100%

6.1 First common causes of delay related to external factors:

Table 4 shows the external factors categories as the largest percentage (41.7%) from the overall top twelve causes of delay in Dam project. Therefore, causes of delay as seen by project parties related to the external factors are as follows:

6.1.1 Severe weather condition (1st overall rank :)

The most and top overall rank agreed by all project parties is severe weather condition with overall (IMP.I) of 70.1%. Most delays in Dam projects were caused by severe weather. For example, Dams were exposed to heavy rains during construction phases between 2007-2010 which led to heavy floods that hit Oman, such as Gonu Cyclone in June 2007 and Phet Cyclone at the end of May 2010. Moreover, most wadis in Oman flowed in high speed flash flooding, including wadis which were involved in Dams under construction at that time. In addition, Dam projects were exposed to destruction during this case, because the weather could cause flooding and consequently lengthy delays in work schedules and cost overrun. This type of external factor mostly occurs due to the absence of responsibilities assigned in contract bonds from all project parties. For example, lack of documented data about weather conditions, poor layout of project sites, and poor drainage systems around the Dam projects side as precautions.

6.1.2 Uncertainty in ground condition (3rd overall rank):

This external factor related cause was ranked by project parties as third overall (IMP.I) with 85.9% of top twelve causes of delay in Dam projects. This cause is the most frequent cause of delay in Dam projects because Dam projects are constructed in a wide area, so the ground condition needs more investigation. On the other hand, regarding unforeseen underground strata aquifers, it should lead to cover all investigation areas, but this operation is very costly.

6.1.3 Natural effects during construction work (8th overall rank):

Natural effects during construction work cause related to external factors had an overall IMP.I of 55.7%. This cause is similar to causes of severe weather and uncertainty in ground condition, but the difference is in Oman climate changes between very hot weather during summer and cold weather during winter. Moreover, lack of local laborers to work in Dam projects leads to importing foreign workers, mainly from India, Bangladesh, and Pakistan. Most of them are not familiar with natural effects during construction of Dams, which consequently reduces productivity of the manpower. Additionally, laws and regulations in Ministry of Manpower determine the work time in summer, and suspend work if the temperature reaches 50 degrees Celsius.

6.1.4 Delay of obtaining permit from the different government authorities (11th overall rank):

This cause of delay, ranked with 54.1%, is caused by the difficulty of obtaining permits from different government authorities, such as Ministry of Regional Municipalities and Water Resources, Ministry of Housing, and Ministry of Transportation.

6.1.5 Land acquisition (12th overall rank):

The last external cause of delay in Dam projects was ranked as land acquisition with an IMP.I of 53%. This cause of delay follows the same trend as found in previous causes of delay. Absence of proper communication channels between clients and local people in the earlier stage during planning stage study leads to severe misunderstanding from the community. Therefore, requests to compensations and consequences delay the execution of Dam projects.

6.2 Second common causes of delay related to clients:

Table 4 shows the client related group of delay causes was ranked second with 33.3%in accordance with the overall despondences ranked as follows:

6.2.1 Change orders (2nd overall rank):

All project parties agreed together and ranked change orders as the second-most important cause of delays in Oman Dam projects with overall an IMP.I of 69.1%. Change orders from the client side are one of the most significant causes in Dam projects leading to delay. Change orders result in delays due to many reasons; for example, clients requested additional work during the construction stage of Dam projects, because the client did not define the project requirements from the early stages. Change orders impede both consultants in the case of modifying the existing design and specifications, and the contractors in the case of rescheduling the project progress and develop of the working team for additional work. Generally, change orders consume additional time and money.

6.2.2 Executive bureaucracy in the client's organisation (5th overall rank):

The overall rank of this cause of delay was fifth cause with an average IMP.I of 57.9%. Both consultants and contractors specified the client bureaucracy in government agencies as the significant cause of delay. For example, clients need to receive approval from several government agencies, in addition to a lengthy payment process, which might take more than four weeks. This contributes to delays in Dam projects.

6.2.3 Difficulty of defining project requirement (9th overall rank):

This cause was ranked as ninth out of the top twelve of (IMP.I) causes of delay with 55.4%. Both contractors and consultants individually ranked this as fifth and sixth) respectively, while the clients ranked it as 25th. Both consultants and contractors indicated the difficulty of defining project requirements from the client is a significant cause leading to delays in Dam projects. Many clients experience difficulties in this cause due to many reasons, such as lack of experience in Dam projects and high authorities in the government agencies requesting to change the purposes of Dam construction from the initial design to other new purposes. Therefore, this cause leads to an increase of change orders and results in additional time and cost.

6.2.4 Slowness of decision making process (10th overall rank):

This cause of delay in Dam project is caused by clients and was ranked as tenth overall (IMP.I) with 54.5%. Both consultants and contractors blame the client. The result indicates the client has a large responsibility in delays of the Dam projects because of very slow decision-making processes. This is due to that the fact that most client representatives do not have a right or authority to make decisions on time. Generally, the people who have a right to make decision have high qualifications in management, and lack awareness in technical performance.

6.3 Third common causes of delay related to Consultants:

Results from Table 4 based on different responsibilities (sources) of delay shows that causes of delays in Dam projects caused by consultants and their responsibilities have a percentage of 16.7% of the overall top

12 causes of delay in Dam projects in Oman. Also table 4 illustrates two causes of delay under consultant related causes. Brief discussion and explanations for each cause delay are as follows:

6.3.1 Feasibility Study did not cover all aspects (6thOverall rank):

Feasibility study cause has a major impact on project delays with a percentage of 57.5% of overall IMP.I. During feasibility studies, the client spends huge amounts of money, especially in Dam projects. However, most consultants during this stage do not cover all aspects. There are many reasons behind this, such as inadequate experience of consultant teams, insufficient information provided from the client, or, in other words, difficulties in defining project requirements from the client side. As well as, there is a gap between the feasibility study stage and execution stage; during that duration, it can lead to the necessity to update and review the initial feasibility study due to daily changes and innovation of new technologies in construction. In addition, there is often a lack of contribution from the local people during the feasibility study stage.

6.3.2 Mistakes in Soil Investigation (7thOverall rank):

A mistake in soil investigation was ranked seventh with an IMP.I of 57.3%. Because it is not reasonable to cover all areas of Dam projects in soil investigations because it is a very lengthy process, and in some cases investigations have to cover around 2 km. Therefore, clients during this stage find it very difficult to spend a huge amount on the consultants. Whereas, consultants during soil investigation phase, either depends in random sampling or study a similar cases, and consequences mistake ratio was relatively high.

6.4 Fourth common causes of delay related Contractors:

Table 4 indicated the contractors as the fourth responsible source of Dam projects delay with a ratio of 8.3% from the overall top twelve causes of delay. Contractor related causes only ranked one cause of delay as poor site management, which was ranked as the fourth cause of delay out of the top 12 overall causes, with an IMP.I of 58%. Contractor failures in site management lead to causing Dam projects delays. This cause was the most significant cause because site management from contractor side means management of labour, materials, and equipment. This cause occurs due to failures of project managers in their obligations and lack of experience in the implementation phase and inability to control sites properly. Consequently, poor site management leads to negative impacts and weaknesses in the work progress. Figure 2 below shows the overall top 12 out of 60 causes of delay in Dam projects as ranked by project parties. In a general overview, there is agreement between all project parties in ranking the first and second causes. In the third and fourth causes, there is agreement between clients and consultants, while the consultants and contractors also agree in ranking cause seven. Other causes reported had differences between relative values in some causes ranked by project parties.

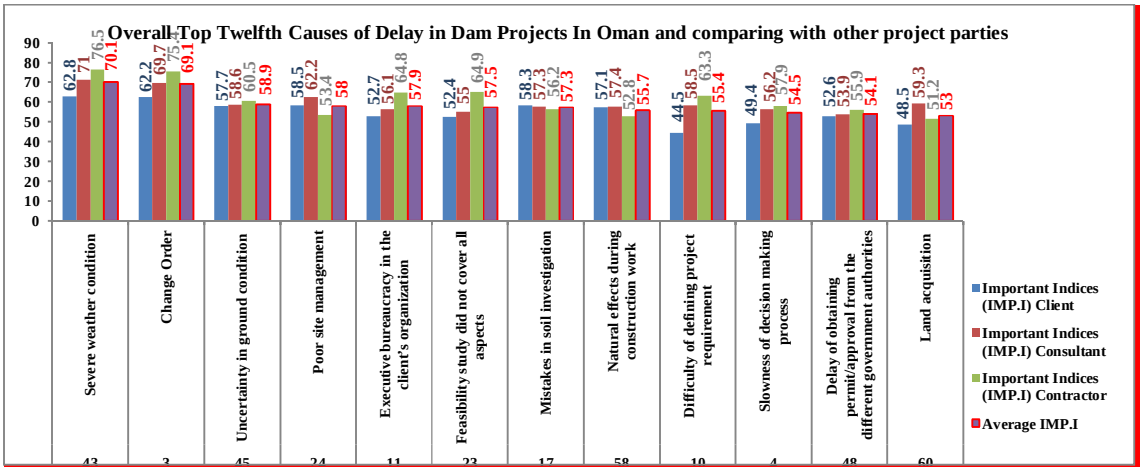

Figure 2: Overall Important causes of delay comparing project parties

Overall the top 12 causes of delays in Dam projects as ranked by all project parties are presented in Table 3. The common overall causes ranked by all project parties were severe weather conditions and change in order. On the other hand, the cause of poor site management was ranked by both clients and consultants as third and came fourth because the contractors individually ranked it as the tenth cause of delay. The overall ranking of the third cause was uncertainty in ground condition, while both clients and consultants ranked the cause as fifth and the contractors ranked it as sixth.

7. Results Discussion

In this study, the top 12 causes of delay in Dam projects in Oman were identified and are shown in Table 5. Also, for a fair comparison, it was necessary to rank relative importance to similar causes in other countries. Among the top 12 important causes, it was found that severe weather conditions caused by external factors and change orders caused by the client are in agreement with previous studies. For example, in the study conducted in the Oman public sector by Alnuaimi and AlMohsin (2013), they ranked severe weather conditions as first, while other studies, such as James et al (2014) and Sharafadeen et al (2015) in Nigerian construction project research, ranked severe weather as eleventh and fourth respectively. In other countries like Indonesia, (Alwi and Hampson, 2003) and Jordan (Sweis et al, 2008), both studies ranked severe weather causes as third. All previous studies indicated that severe weather was fairly common with different ranks. This means the effects of severe weather in developing countries occurred during construction work, but differed in the degree of impacts between the countries. Similar to the change orders cause, the previous studies indicated this cause as most important cause leading to delay in the construction project in general. Table 5 shows around eleven previous studies that identified change order causes.

Table 5: Comparison of Top Twelve Causes of Delay in Dams Projects with previous studies

Top Twelve Causes of Delay	Similar causes identified in literature review	Research Conducted on	Ranked
Severe weather condition	James et al (2014)	Nigeria (Construction project)	Eleventh
	Sharafadeen et al (2015)	Nigeria (Construction industry)	Fourth
	Alnuaimi and AlMohsin (2013)	Oman (Construction project at public sector)	First
	Pourrostam and Ismail (2012)	Iran (Construction project)	Ninth
	Alwi and Hampson (2003)	Indonesia (Construction building)	Third
	Sweis et al (2008)	Jordan (Construction project)	Third
	Alinaitwe et al (2013)	Uganda's (Construction project at public sector)	First
Changes Order	James et al (2014)	Nigeria (Construction project)	Second
	Fatoy (2012)	Nigeria (Construction project)	Sixth
	Ijaola and Iyagba (2012)	Nigeria and Oman (Construction project)	First
	Alnuaimi and AlMohsin (2013)	Oman (Construction project at public sector)	Second
	Assaf and Al-Hejji (2006)	Saudi Arabia (Construction project)	First
	Pourrostam and Ismail (2012)	Iran (Construction project)	Second
	Alwi and Hampson (2003)	Indonesia (Construction building)	Second
	Haseeb et al (2011)	Pakistan (Large construction industry)	Eleventh
	Sweis et al (2008)	Jordan (Construction project)	First
	Ahmed et al (2002)	Florida- USA (Construction project)	Second
Uncertainty in ground condition	Alnuaimi and AlMohsin (2013)	Oman (Construction project at public sector)	Sixth
	Alwi and Hampson (2003)	Indonesia (Construction building)	Fourth
	Haseeb et al (2011)	Pakistan (Large construction industry)	Seventh

Poor site management	Gasasira et al (2016)	Rwanda (Dam Project)	Second
	James et al (2014)	Nigeria (Construction project)	Seventh
	Fatoy (2012)	Nigeria (Construction project)	Second
	Alnuaimi and AlMohsin (2013)	Oman (Construction project at public sector)	Eighth
	Assaf and Al-Hejji (2006)	Saudi Arabia (Construction project)	Fourth
	Pourrostam and Ismail (2012)	Iran (Construction project)	Third
	Haseeb et al (2011)	Pakistan (Large construction industry)	Fifth
	Indhu and Ajai (2014)	India-Chennai (Construction project)	Second
	Sambasivan and Soon (2007)	Malaysian (Construction industry)	Second
Executive bureaucracy	Niazi and Gidado (2012)	Afghanistan (Construction project)	Eighth
Feasibility study did not cover all aspects	No previous research identified this cause		
Mistakes in soil investigation	Gasasira et al (2016)	Rwanda (Dam Project)	Seventh
Natural effects during construction	No previous research identified this cause		
Difficulty of defining project requirement	No previous research identified this cause		
Slowness of decision making process	Al Hadi et al (2009)	Libya (Construction project)	Fourth
	Gasasira et al (2016)	Rwanda (Dam Project)	First
	James et al (2014)	Nigeria (Construction project)	Fifth
	Faridi and El-Sayegh (2006)	UAE (Construction project)	Second
	Pourrostam and Ismail (2012)	Iran (Construction project)	Fourth
	Odeh and Battaineh (2002)	Jordan (Construction industry)	Fifth
Delay of obtaining permit/approval from the different government authorities	Faridi and El-Sayegh (2006)	UAE (Construction project)	Ninth
	Ahmed et al (2002)	Florida- USA (Construction project)	First
Land acquisition	Gasasira et al (2016)	Rwanda (Dam Project)	Sixth

For example, four studies were conducted in African countries, three of them in Nigerian construction projects were conducted by James et al (2014), Fatoy (2012), and Ijaola and Iyagba (2012), with the last one in both Oman and Nigeria. The fourth country in Africa was in Uganda in public construction projects by Alinaitwe et al (2013). Change orders in African countries had the highest score ranking, although it was a different construction project nature. In the Gulf countries, Alnuaimi and AlMohsin (2013) identified change orders as the second-ranking cause in the public sector in Oman. Also, Assaf and Al-Hejji (2006) ranked change orders as the first cause leading to delays in construction projects in Saudi Arabia. From our perspective, change orders increase gradually in construction projects due to many reasons, such as the client changing the scope of work, lack of clarity of client requirements in planning stages, incomplete design, and other external effects.

Alnuaimi and AlMohsin (2013) ranked **uncertainty in ground conditions** as the sixth cause of delay in construction projects in Oman's public sector, while this research ranked it as the third cause of delay in Dam projects. The differences ranking might occur because the previous study's main objective was focused on clarifying the delay problems in construction projects in Oman's capital city (Muscat). Indeed, the existing research related to Dams construction projects, which are different in design, nature of project management, and type of underground foundation. Also, the emphasis on different sizes and natures of construction projects determines the severity of this cause. Similar studies conducted in different countries by Alwi and Hampson (2003) and Haseeb et al (2011) in Indonesian building construction and Pakistan large construction industry ranked uncertainty in ground conditions cause as fourth and seventh respectively.

Poor site management was another common cause of delay in Dam projects, ranked as fourth in this research. Several studies identified this cause as an important cause leading to delays in construction projects as caused by contractors. For example, Alnuaimi and AlMohsin (2013) conducted a study in Oman's public sector, and ranked this cause as seventh. This result is in line with other studies that were conducted by Pourrostam and Ismail (2012) in Iranian construction projects (Third ranked), Assaf and Al-Hejji (2006) in Saudi Arabia construction projects (Fourth ranked) and by Haseeb et al (2011) in Pakistan large construction industry (Fifth ranked). Indeed, it was the second most severe cause of delay as ranked by Gasasira et al (2016) in Rwanda Dam projects, Fatoy (2012) in Nigerian construction projects, Indhu and Ajai (2014) in India-Chennai construction projects, and Samasivan and Soon (2007) in the Malaysian construction industry. Generally, poor site management is due to the contractor not having the capabilities to manage the site properly in Dam projects rather than other infrastructure construction projects. Also, it is due to the conflicts that arise during the construction site phase without responding and controlling the risk on time by the project parties. Moreover, it is necessary to properly plan Dam projects from the initial stage to avoid problems manifesting throughout the project and consequently delaying the project at various stages.

Executive bureaucracy in the client's organisation ranked fifth overall as a cause of delay in Dam projects. The results in table 5 indicated the government agencies are responsible in delaying the Dam projects. According to Niazai and Gidado (2012) study conducted about Afghanistan construction projects, bureaucracy was ranked eighth. Furthermore, bureaucracy in the client's organisation was absent in most of previous studies. Through the divergence of views of previous studies about this cause of delays, it was observed that the Dam projects required receiving approval from a larger number of government agencies, compared to other infrastructure construction projects. In addition, there is an overlap of common interests between several Ministries related to the Dam sites.

Also, Table 5 illustrates three main causes of delays in Dam projects in Oman based on the result of the survey. Project parties identified causes such as feasibility study did not cover all aspects (Sixth ranked), natural effects during construction work (Eighth ranked), and difficulty of defining project requirement (Ninth ranked). Generally, **Feasibility study did not cover all aspects** due to requiring huge amounts of money because the nature of Dam projects are different in design, soil investigation problems, geography of Dam location, size and volume of the project, and long time periods between feasibility studies and execution phase. **Natural effects during construction work** are categorized as external factor contributing to delays in Dam projects in Oman. Apparently, this cause exceeded the expected forecasting effects a few years ago, because of uncontrollable weather and climate change. For example, during summer the temperature is very hot, and the workers are unable to work during the daytime. In addition, as per the laws and regulations in Oman, the workers must daily suspend the work for three hours because of the increase in temperature. **Difficulty of defining project requirements from the client side,** this cause of delay is common due to changes in thinking from the first decision maker to others after replacement as well as, the lack of experience of decision makers or changes in the strategic plan to other purposes. In previous studies conducted in several countries, the three previous causes of delay were not ranked as significant causes of delay in construction projects. Therefore, most of them are related to construction projects such as large construction industry, building projects, and road projects.

Mistakes in soil investigation, this cause can lead to delays in the Dam project in Oman. This cause occurs due to lack of feasibility studies. The consultant during soil investigation depends on previous documented sources of data availability, and takes by random sampling. Whenever there is a mistake in soil investigation, there is additional work and change orders are required. Gasasira et al (2016) identified the mistake in soil investigation as a significant cause of delay in Dam projects in Rwanda and ranked seventh.

The tenth ranked cause of delay in Dam projects was **slowness of decision making process** caused by the clients. From table 5, six studies agreed in identifying this cause, but disagreed on the ranking. Previous studies computed it between first and fifth. For example, Al Hadi et al (2009) in Libyan construction project (Fourth ranked), Gasasira et al (2016) in Rwanda Dam project(First ranked), James et al (2014)in Nigerian construction project (Fifth ranked), and Faridi and El-Sayegh (2006) UAE construction project (Second ranked). From previous studies, it is clear that slowness of decisions was a common cause in various construction projects. Also, this cause can be seen in several countries located in Africa, Asia, and Gulf countries. This cause occurred in client's organisations due to various reasons, such as client's representatives do not have rights to make decisions on time, and the decision makers also lack technical experience, so there is a space between managerial and technical qualifications. On the other hand, around twenty studies examined in this research were conducted in several countries to identify the causes of delay in construction industry, and most of them disagreed that "slowness of decision making process" had a major impact on delays. This was ranked with the lowest score.

The overall importance indices ranked as eleventh and twelfth were delays in obtaining permits from the different government authorities and land acquisition, respectively. Both causes of delay were categorised as external factors. Table 5 shows the results indicate that **delay of obtaining permit from the different government authorities** contributed to the total delay in construction projects. In a neighboring country to Oman, Faridi and El-Sayegh (2006) conducted a study of UAE construction projects, and ranked the delay in obtaining permits from different government authorities as the ninth cause leading to delays in construction projects. Similar studies conducted in the USA (Florida) by Ahmed et al (2002) ranked this cause of delay first. Based on the findings of previous studies, the process of obtaining approval from

different departments takes a long time from submitting an application of the project until all documents have been reviewed and approved. As well as obtaining approval to Dam construction projects requires a duration of more than one month, due to needing approval from several ministry services.

Land acquisition cause was one of the most significance causes of delay in Dam projects especially. From all previous studies, only one study identified land acquisition, by Gasasira et al (2016) in Rwanda Dam projects, and it was ranked as the sixth highest cause leading to delay. Land acquisition is caused by external factors, and is due to a lack of communication channels in advance between clients and local people, misunderstanding of local people toward Dam project benefits, and in some cases due to claims from late compensations of land clients.

8. Conclusion

Delay is a global phenomenon in the construction industry and is annually increasing in developing countries; delays are not exceptions in Dams construction projects. 60 causes of construction delay, which were used in the questionnaire, were identified from the literature review, and categorised into four groups: causes related to clients, causes related to consultants, causes related to contractors and causes related to external factors. Data collected were analysed according to frequency, severity, and importance indices. Moreover, 12 top causes were selected based on the Pareto principle 80/20 and these causes were analysed and discussed with respect to project parties and their responsibilities. The result revealed that first and second overall causes were agreed in ranking from all project parties, as well as the sources of those causes are shared between external factors and clients, respectively.

In addition, the results obtained from this research were compared with similar studies related to delays in construction projects in several countries. Generally, high similarities were found in the following causes of delay: severe weather conditions (1^{st} ranked), change orders (2^{nd} ranked), uncertainty in ground condition (3^{rd} rank), poor site management (4^{th} ranked), and slowness of decision making process (10^{th} ranked). Whereas, fewer similarities were found the following causes of delay: executive bureaucracy in client organisation (5^{th} rank), delay of obtaining permit/approval from the different government authorities (11^{th} rank), and land acquisition (12^{th} rank). Furthermore, it was found there is disagreement between the current results and the results from previous studies about the following causes: feasibility study did not cover all aspects (6^{th} ranked), natural effects during construction work (8^{th} rank), and difficulty of defining project requirements (9^{th} rank), which were obtained in outcomes from case studies. Based on the findings, a suggested set of potential solutions to each 12 overall causes of delays are categorised under clients, consultants, contractors, and external factors, along with a general recommendation being made.

9. Recommendations

Delays are inevitable in Dam construction projects in Oman; therefore, based on the results and findings of this research, the following recommendations are suggested to help professionals in Dam projects to deal with and manage delay causes in Dam projects.

9.1 Recommendations Related to External Factors

9.1.1 Severe Weather Condition

1. The contract award should be schedule according to external weather severity such as seasonal rain and temperature periods.
2. The contractor should modify the working time during summer heat.
3. Proper planning from all stakeholders to avoid or mitigate unforeseen conditions.

9.1.2 Uncertainty in Ground Condition

1. Require more data collection from the field of Dam construction projects with intensive laboratory testing for ground conditions.
2. The staffs that deal with Dam construction project should have a high training in geotechnical aspects.

9.1.3 Natural Effects During Construction Work

1. Natural effects are uncontrollable causes in Dams projects, therefore, during pre-construction work, there should be required a set of potential assessments planned for the natural risk such as environmental impact.
2. Gathering all data about main wadis follows and branches of waterways, to set emergency plans as precautions if heavy rains occur.

9.1.4 Delay of Obtaining Approval From the Different Government Authorities

1. There are challenges during obtaining approval, so the suggestion provided to fix strict deadlines to various government agencies to approve each project application.
2. Another option to accelerate the approval processes within government is through open independent valuation committee that is concerned for all project approval in each sector.

9.1.5 Land Acquisition

1. Client with the local governor who has a formal legal right and local land owners sit together and conduct a brief explanation about the aim and objectives of construction for the Dam, as well as to clarify the desired returns of the project to the state and society.
2. Pre-construction of Dams, the client should clear inventory to all land owners that are affected by the Dam project, with alternative options offered in the compensation process, to ensure settlements the land owners requested.
3. Accelerate the compensation process before project commencement.

9.2 Recommendations Related to Client

9.2.1 Change orders

1. Change orders in the public sector lead to cost and time overrun, so to improve delivering Dam projects on time, the client should change the current policy about Dam projects management.
2. Change orders due to unanticipated field conditions, the client should ensure survey was accurately covered without making assumptions.
3. The client should have a clear picture about the project, from day one until completion of the project to avoiding changing the scope of work, additions to and omissions of work. Also taking precautionary steps to preserve the project within the time schedule and at or below budget.

9.2.2 Executive Bureaucracy in Client Organization

1. Bureaucracy in public organisation is one of the major challenges in most developing countries. The recommendation to mitigate the bureaucracy within government routine is through opening an electronic window.
2. Limit of administrative regulations which are working depend on hierarchy, by distribution of the authorities within organisation.

9.2.3 Difficulty of Defining Project Requirements

1. Client representatives should have potential to define the project requirement currently and in the future.
2. Clear language use in contract documents to avoid misinterpretation of requirements and misunderstandings, as well as allocating time to briefing.

9.2.4 Slowness of Decision Making Process

1. Decisions makers should have technical awareness about Dams projects.
2. Distribution of authorities in client organisation to concerned professionals in Dams projects.
3. Give entire independence related to decision making about Dam projects to the water sector, which is now under the Ministry of Regional Municipalities and Water Resources in Oman.

9.3 Recommendations Related to Consultant

9.3.1 Feasibility Study Did Not Cover All Aspects

1. The client and consultant, based on the result of feasibility study, should provide a clear decision.
2. The client must strengthen financial resources toward feasibility studies in Dam projects.

9.3.2 Mistakes in Soil Investigation

1. Lack of soil investigation can lead to defects in the structure of Dam construction projects, such as cracks in Dam main body, resulting from unsettled ground foundations. The consultants should cover all Dam areas by soil investigations before the construction work is established and report to the client, who can then create the suitable design appropriate to the soil condition.
2. The consultant should be responsible after submitted the soil investigation report to the client, if any defect in design is due to mistakes in soil investigations, that includes obvious guarantee and under strict legal terms.
3. Use geological mapping, geophysical surveys, pit excavation, and seismic surveys to determine the depths and underground strata.

9.4 Recommendations Related to Contractor

9.4.1 Poor Site Management

1. The main contractor should make efforts to manage their team efficiently and effectively.
2. Project manager should have full awareness about management system through comprehensive training, to able lead the work team, as well as sub-contractors.
3. The client side should select the right contractors with required capabilities and experience in Dam projects constructions, and do not select the lowest bid without recommending contractor.

9.5 General Recommendations Related to Project Parties

The following points are recommended in general to reduce the effect of causes of delay in Dam projects in Oman;

1. Obtain early approval from the different agencies in government.
2. The client should establish and formulate a good channel of communication between all of the stakeholders during construction work, to avoid any misunderstanding or further dispute.
3. Consultants should daily ensure that all construction work is carried out according to the plan explicitly and correctly, taking into consideration that the key factors are time, cost and quality.
4. The contractors should have adequate experience in Dams projects with qualified teams for work and employ a project management system in their organisations, as well as including proper planning, scheduling, and supervision of the work to avoid any delay.
5. Change orders from the client should be simultaneously within the project duration to avoid negative impact to other activities in the project.
6. Project parties work together to transfer the unforeseen risk to insurance agencies to mitigate the delay impacts.
7. Government system dealing with obtaining permits in Dam projects needs to continue to be evaluated.

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