

Assessment of Cost and Extent of Delays in Public Sector Construction Projects in Aseer Region, KSA



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Abstract: *The time performance of projects i.e. delay of construction projects is considered as one of the alarming problems around the world that has passive effect on the society development as well as on the country economy. The time performance of construction projects varies with country, region, project type and the perspectives of various stakeholders. The purpose of the paper is to know the extent of delay in the government sector projects in Aseer region, KSA and identifying whether the delay extent is natural or large compared to other areas. A total number of 228 public sector construction projects awarded in one decade have considered for the study purpose. The methodology for the project delays studies is as follows, collection of projects information from the main sources, classifying them according to the project size limits, analyzing the available data, knowing the delay size in every sector and comparing the delays of the different projects to identify the most delayed projects as well as those completed on time. Analysis of delays shows that the majority of construction projects in the Aseer region have exceeded their time and the most significant delay among government sectors was the Directorate-General for Health Affairs. The extent of delay in construction project decreases with the progress of country.*

Keywords: *Contract Duration; Construction Project; Public sector; Extent of Delays.*

I. INTRODUCTION

The performance of construction projects are considered as an important measure for the development and progress of the society, and a mirror reflecting the nation civilization and people's advancement. Despite the important role represented by the projects, they are subject to several problems to achieve their objectives in all their stages. These problems are varying in nature, but the most important one is the delay in accomplishing a stage of the project or all stages of the project. Falqi [1] defines the construction delay in construction projects as the time difference between the date of termination of project specified in the contract and the effective date of the completion of the project. According to

Assaf and Al-Hejji [2], the project delay is an overrun beyond the scheduled project completion time. Trauner et. al. [3] describes the construction delays as something unexpected and unplanned delayed activity in the schedule of the project. Enshassi et al. [4] have reported the different types of construction delay in the project as critical and non-critical, concurrent, non-excusable and excusable delays, and internal and external delays. Critical delays concern the progress of an activity on a critical path. Concurrent delays involve the incident of at least two independent delays at the same time. The excusable type delays are those that are beyond the contractor's control. The internal delays arise from the project stakeholders, external delays derive from the third parties involved within the project delivery process. The project delay has many causes leading to passive effects depending on the project significance. The delays in accomplishing project have resulted in social harms on the whole society as well as it is insidious to participating and to benefiting the projects. The resultant passive effects from the delay reflect in the increase of cost of the project, imposing penalty on the contractor, increase in equipment quantities, wastage of man and materials, decrease in efficiency and lengthy litigation. The delay may also affect the quality of construction projects [5].

II. CONSTRUCTION PROJECT DELAYS STUDIES

The considerable attention is being paid for decades in construction project delays studied. The construction project delays are identified as main causes according to country, region, project type and procurement methods, as well as from the perspectives of various stakeholders. Durdyev and Hosseini [6] present a systematic review of research works around the globe for causes of delays on construction projects during 1985 to 2018. They identified ten most common project delays as weather/climate conditions, poor communication, lack of coordination and conflicts between stakeholders, ineffective or improper planning, material shortages, financial problems, payment delays, equipment/plant shortage, lack of experience/qualification/competence among project stakeholders, labour shortages, and poor site management. Shebob et al. [7] provide case studies analyzing project delays and comparative studies on project delays between different countries. Abedi et al. [8]

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have comprehensively reviewed the construction project delays and proposed thirty significant mitigation measures in order to evade or decrease the negative effect of construction delay. Faridi and Al-Sayegh [9] study observed that project delay is the most serious and frequent problems in the Saudi Arabian construction industry. Assaf and Al-Hejji [10] has surveyed the time performance of different types of construction projects of eastern province in Saudi Arabia to determine the causes of delay according to each of the project stakeholder importance i.e. contractors, client and consultants, and according to four other variable namely materials, labor, contract and project-related causes. They studied frequency, complexity, and significance of the reasons for delay. The importance index of each cause is calculated as a product of both frequency and complexity indexes of each cause. The most common cause of delay identified by all the three stakeholder of the project is the “change order”. The contractors considered severe causes of delays are related to client. The client and consultants realize that awarding to the lowest bidder is the highest frequent factor of delay. Most of the contractors and half of consultant have indicated that average of time overrun is between 10% and 30% of original duration. Al-Kharashi and Skitmore [11] also surveyed the public sector projects aimed to identify the reasons for delays that form the greatest impacts considering seven grouping of causes and the extent to which these impacts can be implemented to minimize the delays in the Saudi Arabian construction industry. The analysis reveals that the most influencing current cause of delay is the lack of qualified and experienced personnel which is attributed to the considerable amount of large, innovative, construction projects and associated current undersupply of manpower in the industry. Mahamid et al. [12] study the construction projects in Saudi Arabia to identify the delay causes in northern province construction projects from consultants’ viewpoint. The study concluded that the top delays causes in construction projects in Saudi Arabia from consultants perspective are bid award for lowest price, changes in material types and specifications during construction, contract management, duration of contract period, fluctuation of prices of materials, frequent changes in design, improper planning, inflationary pressure, lack of adequate manpower, long period between design and time of implementation, payments delay, poor labor productivity and rework. The review of public construction projects in KSA by Alotaibi et al. [13] found that key element taking part in frequent incident of delays in building construction projects are ineffective planning and scheduling of the project by the contractors; poor qualification, competence and experience of the contractors’ staff; delay in progress payment by the client; and change order by the client. They also presented the details of project management principles that bring into practice to reduce the cases of construction delays in KSA. Al-Barak [14] studied the prime causes of failure in construction industry in Saudi Arabia by surveying 68 contractors and about 34 different causes of failure. He concluded that lack of experience, poor estimation practices, bad decisions in

regulating company’s policy, and national slump in the economy are the severe factors. Alhajri and Alshibani [15] conducted surveys and experts interviews to identify, assess, and rank the Critical factors causing delays during the construction phase of petrochemical projects in Saudi Arabia. They found that the most influencing factors for are poor site management and supervision by contractors, conflict between the main contractor and subcontractor, poor planning and scheduling of projects by the contractor, delays in material or equipment delivery and delays in handing over construction site to the contractor. Alzara et al. [16] submit a case study of university construction project to minimize the causes of delays in Saudi Arabian construction projects using the Performance Information Procurement (PIP) System.

Koushki et al. [17] studied the causes of delays and cost increases in the construction of private residential projects in Kuwait and found that the amount of time-delay and cost-increase (overrun), rise with an increase in the total cost of a residential project. They also found that private residence clients, who spent more time on the pre-planning phase, spent more money on the design phase, issued less change orders, selected more experienced contracting companies, and experienced less time delays and cost-increases during the implementation phase of their residential projects. A major factor contributing to the sample projects time-delay and cost-increase was the insufficiency of money and time allocated to its design phase. Ren et al. [18] studied the key influencing factors for the cause of delays in Dubai construction projects by conducting questionnaire survey and interviews. The research focused on the specific operational surroundings of Dubai construction projects and observed the root reasons for the delay contributed by the major project partners. The results show that the major causes of delays vary from the unrealistic project duration, nominated sub-contractors, and the culture impacts. Alnuaimi and Al-Mohsin [19] evaluated the problems resulted from delay in completion of construction projects in Oman. He concluded that average time delay in construction projects in Oman during 2007-2009 is more than 40 per cent of the planned time and maximum delay was about 300 per cent which shows the significance of studying the planning and efficiency of specialized construction projects. Odeh and Battaineh [20] conducted a survey to identify the most important causes of delays in construction projects in Jordan with traditional type contracts from the viewpoint of construction contractors and consultants. Results of the survey indicate that contractors and consultants agreed that client interference, inadequate contractor experience, financing and payments, labor productivity, slow decision-making, improper planning, and subcontractors are among the top ten most important factors. Noulmanee et al. [21] investigated influencing factors of delays in highway construction in Thailand and concluded that all stakeholders involved in projects can cause delays.

However, prime factor come from inadequacy of sub-contractors, organization that lacks of sufficient resources and coordination and, incomplete and unclear drawings. The study suggested that delay could be minimized by discussions that lead to understanding. Alwi and Hampson [22] conducted survey to identify the most influencing causes of construction delays within building projects in Indonesia from the large and the small contractor's viewpoint. The total of 31 variables that could cause delay were grouped into six categories, People, Professional Management, Design and Documentation, Materials, Execution and External. The results show that there is an agreement between the large and the small contractors towards individual causes of delay, whereas, the large and the small contractors have little agreement in relation to ranking the groups of delay variables. The professional management group was ranked the highest and the external groups was ranked the lowest by large contractors. Whereas, small contractors ranked the design and documentation group as the highest and the execution group as the lowest. Kazaz et al. [23] conducted a survey to examine the causes of time extensions in the Turkish construction industry and to evaluate the levels of their importance of 34 potential delay factors affecting project duration. According to the results, "design and material changes" was found to be the most predominant factor, followed by "delay of payments" and "cash flow problems". In terms of importance levels of factor groups, financial factors were found to be the first group, while environmental factors were the least effective group. It is also pointed out that managerial causes of delays are encountered in developed and developing countries, whereas financial causes are experienced in developing countries only. Mydin et al. [24] conducted a survey to recognize the contributing agents of project delays in Malaysian private housing dependent on developer's doctrine. They identified 28 causes and 6 consequences of project delays from 4 different factors of delays, namely client factors, consultant factors, contractor factors and external factors. The top ten main agents that contributed to the project delays are poor weather and site conditions, poor site management, incomplete documents, inexperience persons involving construction, contractor financial problems, contract modifications by the client, and delay in approving of main changes in the scope of work, contractor coordination problem with other parties and construction mistakes and defective works. Alinaitwe et al. [25] investigate the causes of construction project delays and cost overruns of public sector project in Uganda according to frequency, severity, and importance indices. The five most important causes of delays in Civil Aviation Authority projects are found as changes to the scope of work, delayed payments, poor monitoring, and control, the high cost of capital and political insecurity and instability. Couto and Teixeira [26] evaluated of the construction project delays in the Portuguese construction and opinioned that only an integrated approach may avoid or minimize the delay causes in construction. Haseeb et al. [27] conducted a survey to evaluate the problems of projects and effects of delays in the construction industry of Pakistan. The

survey shows that majority of delay factors are relevant to client factor. They suggested that for reducing the construction delays, client must have strong economical ability and financial arrangement for project, and correctly time decision. Most factors related to consultant it is due to not understanding the client necessities, not having proper project information and incomplete drawings. The most common factor of delay are natural disaster in Pakistan like flood and earthquake and others factors like financial and payment problems, improper planning, poor site management, insufficient experience, shortage of materials and equipment etc. Haseeb et al. [28] ranked the causes and effects of delays in large construction projects of Pakistan based on the relative importance index (RIR). They found 16 important causes of delay as finance and payments, inaccurate time estimation, quality of material, delay in payments to supplier and subcontractor, poor site management, old technology, natural disasters, unforeseen site conditions, shortage of material, delays caused by subcontractors, changes in drawings, improper equipment, inaccurate cost estimation, change orders, organizational changes and regulatory changes. The effects of construction delay i.e. time overrun, cost overrun, abandonment, negotiations and court cases and dispute, are also discussed. Gidado and Niazai [29] conducted a comprehensive survey to study the time performance of various construction projects in Afghanistan according the views of stakeholders. The findings show that out of 83 causes of delay, the main critical factors that cause construction delays in Afghanistan are security, corruption, poor qualification of the contractor's technical staff, payment delays by clients, and poor site management and supervision by contractor. It is found that security' and 'corruption' reasons of delay are common between the stakeholders. Abd El-Razek et al. [30] studied delay in building construction project in Egypt, according to responsibility (contractor, consultant, owner and common responsibility) and each delay cause measured on a Likert scale using four options, very important, important, somewhat important, and not important. They concluded that the most important delays causes were, financing by contractor during construction, delays in contractor's payment by client, design changes by client during construction, partial payments during construction, and non-utilization of professional construction/contractual management. Arditi et al. [31] has studied the effect of organizational culture on delay in construction. They explored the relationship between a construction companies' organizational culture and delay, and compared the effect of clan" culture of US and "market" culture of India on project construction delays. The study shows that the percentage of delay relative to project duration is lower in U.S. as compared to India despite the fact that delays are caused by a multitude of reasons.

From the review of project construction delays studies, it is evident that construction delay is a major concern of the construction industry around the world and causes of construction delays differ with country, region, and organizational culture of the country. It is also clear that limited research is available for the extent of delay in construction in Saudi Arabia projects based on the primary data. The propose study is undertaken with aim to know the extent of delay in the different types of public sector projects in KSA Aseer region and identifying whether the delay extent is natural or large compared to other areas.

III. RESEARCH METHODOLOGY

For the sake of achieving the research aims, the researchers have used the descriptive methodology. The scope of this study considered project having cost more than 3.5 million SR in public sector building projects (e.g. hospitals, education, municipalities and road) of Aseer region, KSA. The period considered in this study is for project contracts started in May'2006 and planned to complete before May'2016. The proposed study supposes the delay causes in construction projects as country and region specific. The study uses the data from the primary and secondary sources. For processing of the theoretical part, the secondary data (published literature etc.) is used. The primary data consists of 228 samples from the participating governmental sectors in Aseer Region. The methodology for the propose study of extent of delays in the construction project is as follows:

- Collection of information of the governmental sector projects from the main sources (primary data)
- Classifying them according to the project size limits
- Analyzing the available data, knowing the cost and delay size in every sector
- Comparing the delays of the different projects to identify the most delayed projects as well as those completed on time

The General research methodology is mentioned in figure 1. The four participating government sectors of Aseer region, KSA and sample size selected in the proposed study are as follows:

- [1] Municipality (66 projects)
- [2] General Directorate of Education (111 projects)
- [3] General Directorate of the Health Affairs (29 projects)
- [4] General Directorate of Roads and Transport (22 projects).

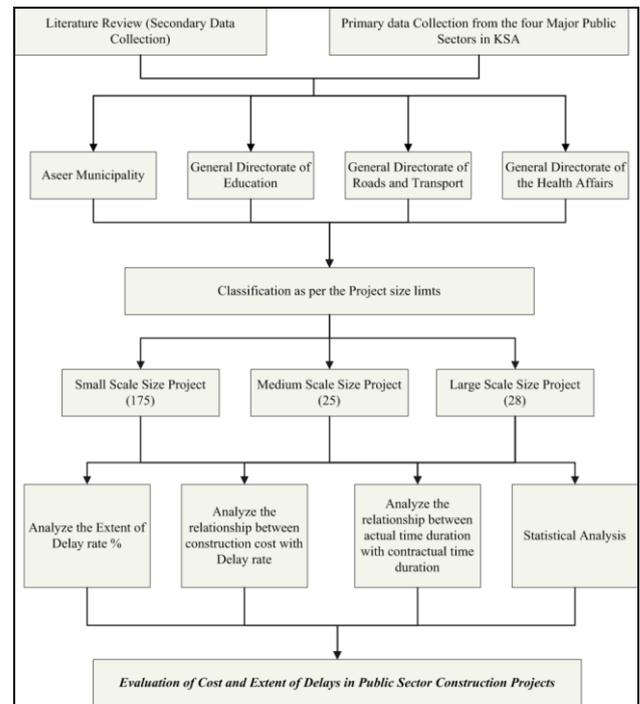


Fig. 1. General research methodology adopted for the study

IV. RESULTS AND DISCUSSIONS

From the review of project construction delays studies, construction delays are clearly a major concern of the construction industry worldwide and the causes of delays in construction vary with country, region, and organizational culture of the country. The research objective is to analyze the delay extent in the four prime public sector projects in Aseer region, KSA. For the purpose of the research, a total of 228 public sector construction projects (e.g. hospitals, education, municipalities and road) granted in one decade. The methodology for the project delays studies is as follows, collection of projects information from the main sources, classifying them according to the project size limits, analyzing the available data, knowing the delay size in every sector and comparing the delays of the different projects to identify the most delayed projects as well as those completed on time. Analysis of delays shows that the majority of construction projects in the Aseer region have exceeded their time and the most significant delay among government sectors was the Directorate-General for Health Affairs. With the technological advancement of the country, the extent of the delay in the construction project is reduced. The following are the analysis results of the delay extent in the four prime public sector projects in Aseer region, KSA and comparing the delay extent among the participating sectors

A. Duration and Extent of Delay rate in public sectors projects

The total of 22 construction projects awarded during 2006-2016 of General Directorate for Roads and Transport are evaluated for the extent of the delay. Table 1 shows the cost and delay rate % of the projects. The projects have minimum contract cost value of SR. 9.9 million with contractual project duration 24 months whereas, the maximum contract cost value of approx.

SR 227 million with contractual project duration 30 months. The minimum and maximum duration of the among the considered construction project are 24 months and 75 months respectively. Figure 2 shows the graphical representation of the relationship between the number of project with time duration and delay rate % for construction project in general directorate of roads and transport in Aseer. All the projects in general directorate of roads and transport in Asir during 2006-2016 are delayed with varying range from 4.48% to 348.63%. It reveals that the maximum project delay extent is found for the project number R5 with the delay rate % of 348.63 over the contractual project duration of 24 months. Figure 2 also shows that projects with lower contract period length of the project have a greater delay rate while those projects with higher contract period length of the project have a lower delay rate.

Table-I. Projects of the general directorate of roads

Sl. No. Projects in Road and Transport	Contractual Project duration in months	Contract cost (SR) '000	Delay rate (%)
R1	68	160,000	19.71%
R2	62	160,000	12.58%
R3	30	226,919	24.33%
R4	65	55,000	45.11%
R5	24	17,999	348.63%
R6	55	62,999	26.85%
R7	52	70,764	124.48%
R8	37	140,000	80.33%
R9	36	124,932	123.98%
R10	51	81,000	86.80%
R11	55	99,977	49.39%
R12	59	96,969	63.50%
R13	75	189,541	4.48%
R14	54	211,8001	20.56%
R15	38	77,574	46.93%
R16	30	60,072	77.78%
R17	46	36,735	27.61%
R18	30	64,062	77.33%
R19	30	48,435	95.67%
R20	24	9,199	24.31%
R21	24	61,990	144.58%
R22	24	30,000	35.69%

and transport in Aseer

Sl. No.	Cont. Project dur. months	Contract cost (SR)'000	Delay rate (%)	Sl. No.	Cont. Project dur. months	Contract cost (SR)'000	Delay rate (%)
M1	24	8,565	0%	M34	12	5,349	34%
M2	22	16,481	122%	M35	15	20,862	0%
M3	12	4,769	19%	M36	9	7,380	6%
M4	13.2	5,974	4%	M37	18	28,245	0%
M5	12	3,850	0%	M38	6	3,999	0%
M6	12	9,248	0%	M39	9	11,017	7%
M7	12	4,300	0%	M40	12	5,569	94%
M8	12	7,791	52%	M41	26.4	16,063	0%
M9	18	4,795	4%	M42	12	3,998	0%
M10	30	50,080	0%	M43	26.5	94,5788	0%
M11	12	10,142	163%	M44	6	18,144	0%
M12	6	4,377	257%	M45	16.2	4,478	51%
M13	26.4	19,837	0%	M46	12	8,076	0%
M14	18	21,001	23%	M47	18	4,928	0%
M15	12	3,648	9%	M48	30.5	12,201	122%
M16	12	7,117	260%	M49	9	18,694	172%
M17	6	5,920	19%	M50	12	11,260	96%
M18	12	17,415	0%	M51	12	39,946	55%
M19	12	12,578	108%	M52	12	15,601	0%
M20	9	11,002	11%	M53	12	69,995	89%
M21	13.2	17,750	0%	M54	34	108,719	125%
M22	12	12,972	9%	M55	22	100,856	207%
M23	18	4,874	0%	M56	12	83,415	341%
M24	18	6,190	0%	M57	24	79,852	0%
M25	12	4,926	246%	M58	18	38,500	333%
M26	12	4,029	43%	M59	24	66,174	103%
M27	21	4,200	0%	M60	12	26,188	0%
M28	24	11,033	112%	M61	12	11,585	0%
M29	12	4,999	349%	M62	42	102,852	89%
M30	18	3,999	158%	M63	40	67,156	56%
M31	9	4,991	0%	M64	10	7,449	0%
M32	12	10,593	0%	M65	12	4,500	40%
M33	18	4,466	68%	M66	12	6,487	61%

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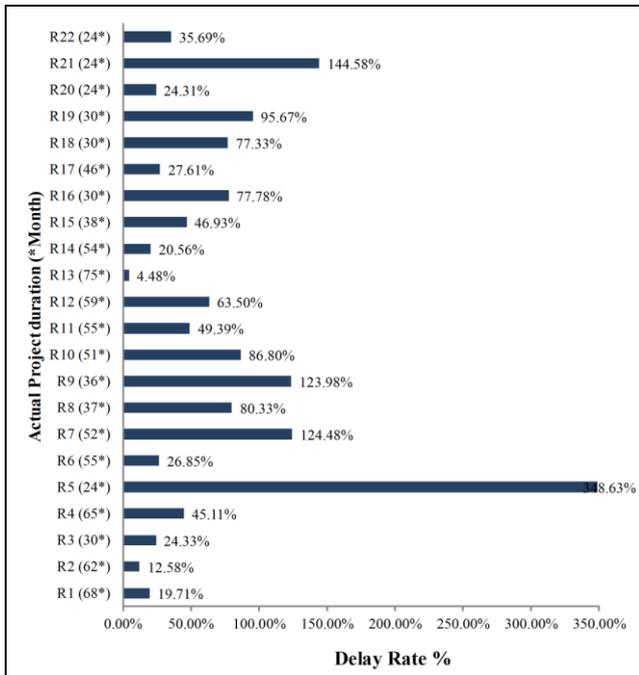


Fig. 2. The relationship between the number of project with time duration and delay rate % for every project

From Aseer Municipality public sector project (KSA), 66 construction projects awarded during 2006-2016 are assessed for the extent of the delay. The projects have minimum contract cost value of SR. 3.6 million with contractual project duration 12 months while, the maximum contract cost value of approx. SR 108.7 million with contractual project duration 34 months (Table 2).

Table 2. Aseer municipality projects

The minimum and maximum duration of the among the considered construction project are 6 months and 42 months respectively. The graphical representation of the relationship between the number of project with time duration and delay rate % for construction project are shown in Figure 3. During 2006-2016, the totals of 66 projects, 27 projects are completed within the time frame whereas others delay with varying range from 4.0% to 349%. It reveals that the maximum project delay extent is found for the project number M29 with the delay rate % of 349 over the contractual project duration of 12 months

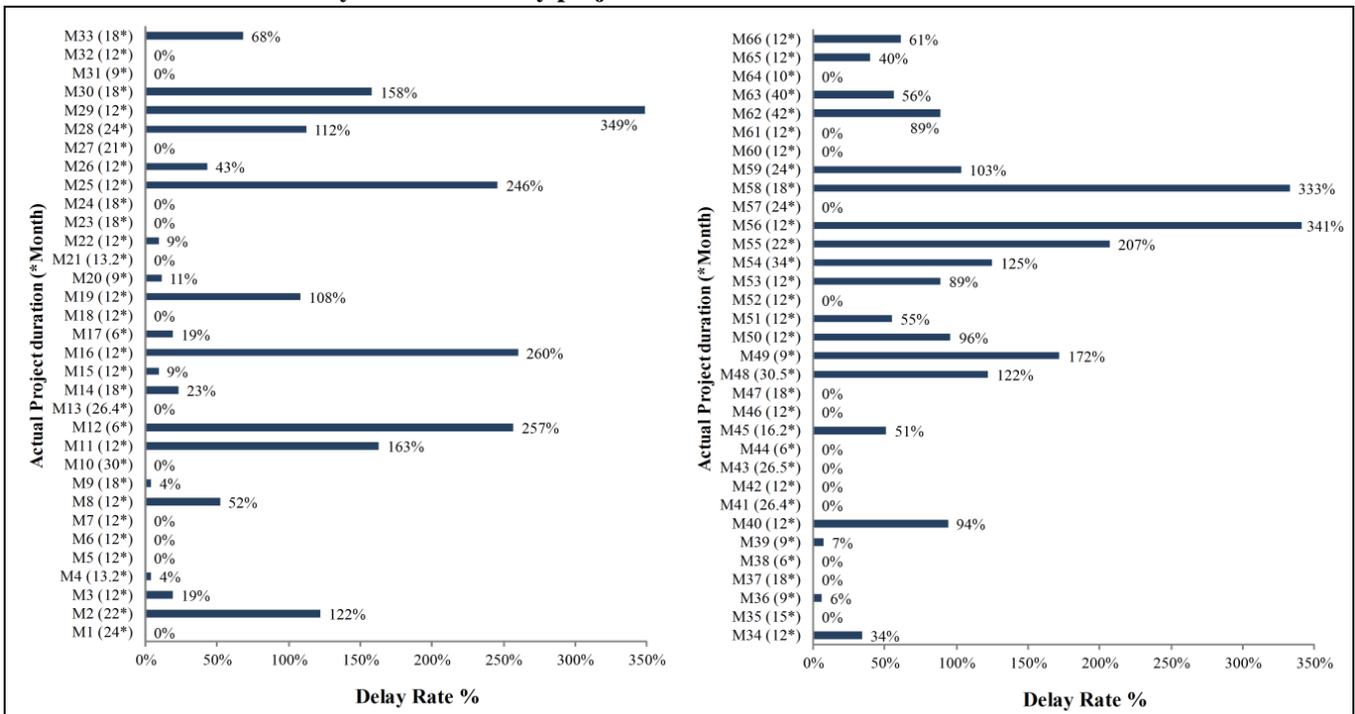


Fig.3. The relationship between the number of project with time duration and delay rate % for every project

The total of 111 construction projects of General Directorate of education projects are selected to evaluate the extent of the delay in the projects. The Table 3 shows the cost and delay rate % of the projects. The projects have minimum contract cost value of SR. 3.5 million with contractual project duration 18 months whereas, the maximum contract cost value of approx. SR 27.5 million with contractual project duration 16 months. The minimum and maximum duration of the among the considered construction project are 11 months and 28 months respectively. Figure 4 shows the graphical representation of the relationship between the number of project with time duration and delay rate % for construction project in general directorate of education projects in Aseer. During 2006-2016, the totals of 111 projects, 16 projects are

completed within the time frame whereas others delay with varying range from 4.1% to 323%. It reveals that the maximum project delay extent is found for the project number E108 with the delay rate % of 323 over the contractual project duration of 11 months. Projects with lower contract duration of the project have a higher delay rate, while projects with higher contract duration of the project have a lower delay rate

The total of 29 projects awarded during 2006-2016 in Health public sector projects are evaluated for the extent of the delay in the construction projects. The Table 4 shows the cost and delay rate % of the projects.

The projects have minimum contract cost value of SR. 3.5 million with contractual project duration 12 months whereas, the maximum contract cost value of approx. SR 216 million with contractual project duration 24 months. The minimum and maximum duration of the among the considered construction project are 12 months and 54 months respectively.

Figure 5 shows the graphical representation of the relationship between the number of project with time duration and delay rate % for construction project in general

directorate Health Affairs projects in Aseer. During 2006-2016, the totals of 29 projects, 2 projects are completed within the time frame whereas others delay with varying range from 23% to 592%. It reveals that the maximum project delay extent is found for the project number H17 with the delay rate % of 592 over the contractual project duration of 12 months. Figure 4 also shows that projects with lower contract period length of the project have a greater delay rate while those projects with higher contract period length of the project have a lower delay rate.

Table-III. Projects of the general directorate of education projects in Aseer

Sl. No.	Contractual Project (months)	Contract cost (SR)	Delay rate (%)	Sl. No.	Contractual Project (months)	Contract cost (SR)	Delay rate (%)
E1	18	21,948,266	17.30%	E56	23	11,939,454	4.12%
E2	22	21,948,266	9.54%	E57	23	20,457,220	35.63%
E3	22	10,668,246	13.10%	E58	23	9,877,067	31.52%
E4	24	26,996,398	41.23%	E59	21	11,984,077	16.69%
E5	22	22,647,791	12.71%	E60	22	12,407,193	90.48%
E6	21	8,846,906	28.62%	E61	25	7,474,284	0.00%
E7	21	8,699,071	7.77%	E62	25	7,281,947	9.30%
E8	23	11,236,447	30.59%	E63	25	11,635,691	6.60%
E9	19	9,756,808	52.25%	E64	22	7,032,873	5.24%
E10	21	11,684,077	58.83%	E65	25	23,673,702	6.21%
E11	23	11,720,882	34.02%	E66	22	9,188,476	1.70%
E12	21	9,743,611	64.77%	E67	22	9,435,485	0.00%
E13	20	6,794,119	11.66%	E68	25	9,209,256	0.00%
E14	20	6,782,520	10.84%	E69	25	13,482,714	9.97%
E15	20	8,359,194	0.00%	E70	25	12,670,730	30.19%
E16	23	6,415,780	10.04%	E71	27	23,894,049	4.47%
E17	22	6,586,475	25.97%	E72	17	5,116,709	186.87%
E18	25	7,520,000	0.00%	E73	25	5,635,419	182.10%
E19	20	5,927,686	82.04%	E74	25	7,159,795	133.24%
E20	20	6,660,220	70.77%	E75	25	6,481,402	178.60%
E21	20	6,419,988	22.53%	E76	25	14,498,473	211.46%
E22	22	6,289,872	0.00%	E77	25	9,286,493	217.09%
E23	20	6,826,797	103.11%	E78	25	7,105,084	250.00%
E24	20	7,107,276	122.95%	E79	25	6,580,765	270.39%
E25	23	8,235,064	169.11%	E80	25	7,000,000	81.51%
E26	16	27,568,547	35.70%	E81	19	5,088,956	38.92%
E27	21	6,481,084	132.42%	E82	22	10,092,939	5.08%
E28	20	7,623,808	31.64%	E83	25	10,474,542	0.00%
E29	16	27,499,080	29.03%	E84	28	10,448,640	10.43%
E30	19	5,117,299	267.08%	E85	25	8,486,455	175.30%
E31	19	5,898,562	12.70%	E86	25	12,947,392	186.50%
E32	19	5,785,032	19.96%	E87	22	11,696,237	233.49%
E33	21	7,131,129	27.07%	E88	22	5,430,190	5.25%
E34	23	8,840,442	13.07%	E89	25	9,909,650	15.99%
E35	22	10,952,905	14.20%	E90	25	7,553,423	8.34%
E36	21	10,529,091	20.06%	E91	19	5,375,385	70.92%

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E37	25	10,850,850	16.82%	E92	25	14,419,911	37.15%
E38	19	6,766,887	119.75%	E93	25	14,114,895	169.72%
E39	21	9,540,966	186.27%	E94	25	8,139,925	108.50%
E40	24	10,009,426	7.95%	E95	25	13,141,644	76.88%
E41	20	7,906,171	26.84%	E96	25	12,100,266	37.20%
E42	22	22,390,427	20.39%	E97	22	12,369,121	13.71%
E43	23	10,352,180	10.41%	E98	22	11,690,545	6.92%
E44	21	9,991,632	0.00%	E99	18	4,300,968	0.00%
E45	27	11,940,214	0.00%	E100	20	4,888,526	0.00%
E46	17	9,998,062	30.23%	E101	18	4,384,824	75.14%
E47	21	9,894,501	8.74%	E102	18	3,537,844	95.99%
E48	26	9,860,001	0.00%	E103	12	4,816,810	79.67%
E49	24	20,311,097	20.68%	E104	19	4,848,710	45.77%
E50	20	9,890,499	35.20%	E105	18	3,826,909	44.97%
E51	27	11,899,254	0.00%	E106	18	4,899,589	187.16%
E52	23	9,998,744	0.00%	E107	19	3,777,523	21.04%
E53	27	11,899,254	0.00%	E108	11	3,860,223	322.80%
E54	23	10,970,784	22.32%	E109	12	4,775,145	219.89%
E55	12	11,942,607	86.79%	E110	19	3,928,450	17.48%
				E111	25	4,834,565	18.17%

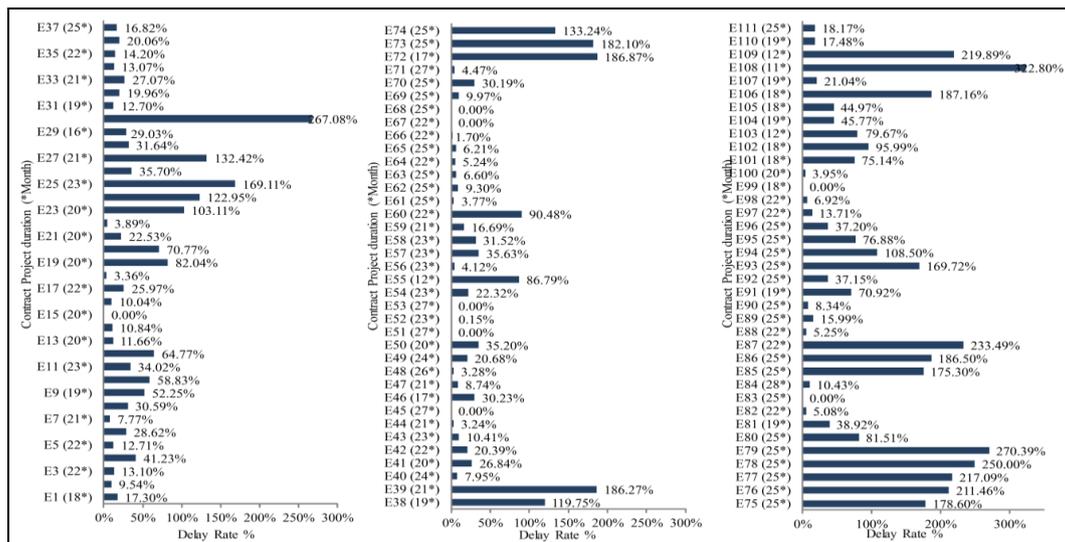


Fig. 4. The relationship between the number of project with time duration and delay rate % for every project in the general directorate of education projects in Aseer

Table 4. Projects of the general directorate Health Affairs projects in Aseer

Sl. No.	Contractual Project duration months	Contract cost (SR)	Delay rate (%)	Sl. No.	Contractual Project duration months	Contract cost (SR)	Delay rate (%)
H1	12	3,500,000	294%	H15	12	3,500,000	542%
H2	12	3,500,000	211%	H16	12	3,500,000	503%
H3	12	3,500,000	250%	H17	12	3,500,000	592%
H4	12	3,500,000	371%	H18	12	3,500,000	505%
H5	12	3,500,000	473%	H19	12	3,500,000	490%
H6	12	3,500,000	136%	H20	12	3,500,000	190%
H7	12	3,500,000	155%	H21	12	5,463,382	205%



H8	12	3,500,000	423%	H22	12	3,644,000	44%
H9	12	3,500,000	284%	H23	24	13,000,000	0%
H10	12	3,500,000	184%	H24	24	23,849,000	23%
H11	12	3,500,000	291%	H25	54	110,500,000	0%
H12	12	3,500,000	273%	H26	36	138,495,000	247%
H13	12	3,500,000	325%	H27	24	24,600,000	122%
H14	12	3,500,000	372%	H28	24	50,000,000	31%
				H29	24	216,000,000	54%

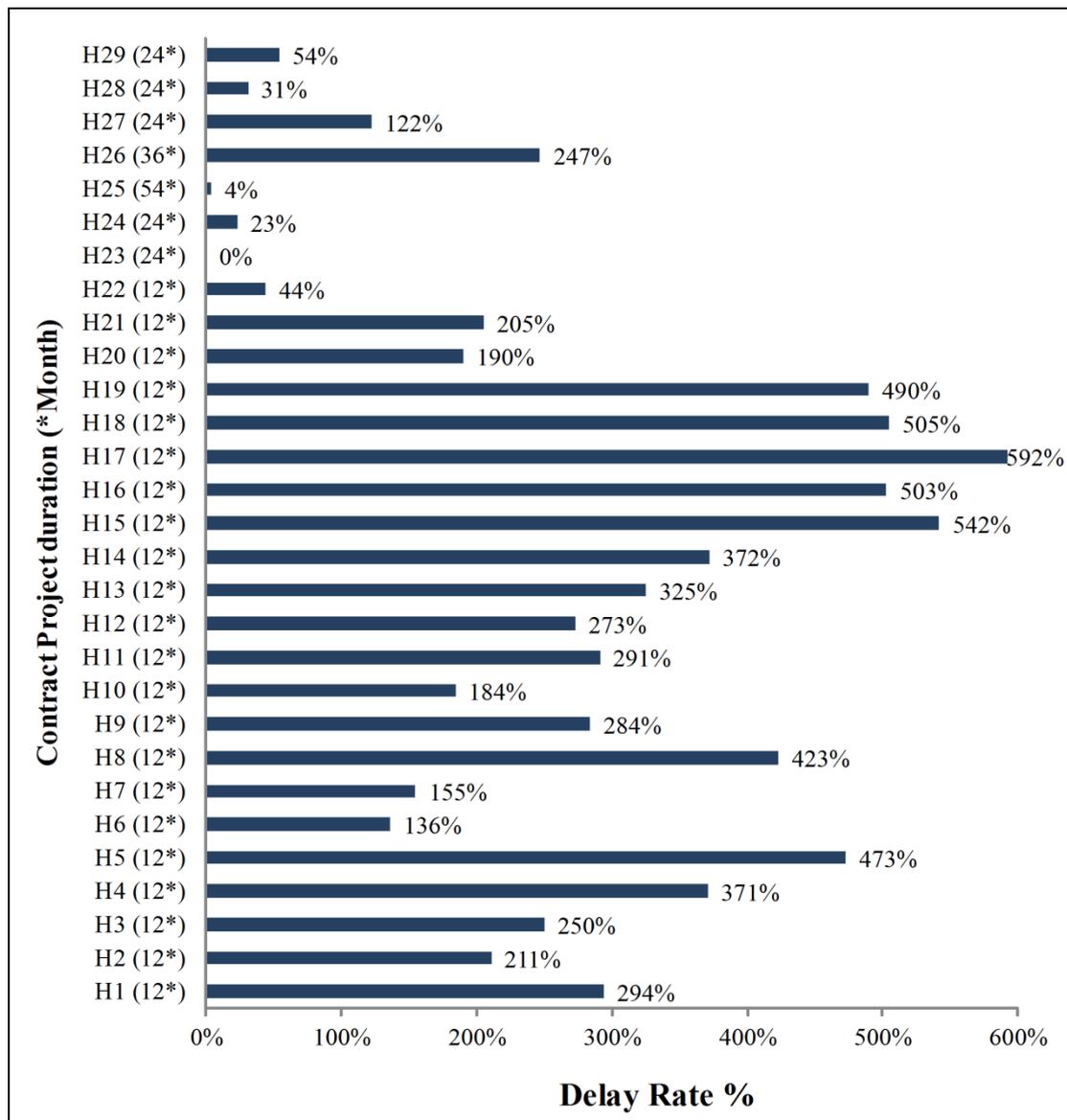


Figure 5. The relationship between the number of project with time duration and delay rate % for every project in the general directorate of Health projects in Aseer

Figure 5 shows the graphical representation of the relationship between the number of project with time duration and delay rate % for construction project in general directorate Health Affairs projects in Aseer. During 2006-2016, the totals of 29 projects, 2 projects are completed within the time frame whereas others delay with varying range from 23% to 592%. It reveals that the maximum project delay extent is found for the project number H17 with the delay rate % of 592 over the contractual project duration of 12 months. Figure 4 also shows that projects with lower contract period

length of the project have a greater delay rate while those projects with higher contract period length of the project have a lower delay rate.

B. Construction Cost and Extent of Delay rate in public sectors Projects

In the present study, the construction cost and extent of delay rate in public sectors projects has been evaluated.

Assessment of Cost and Extent of Delays in Public Sector Construction Projects in Aseer Region, KSA

The public sector projects ((e.g. hospitals, education, municipalities and road) are group into three scale size based on the construction cost of the projects (ref). i.e. small size (<20 million), medium size (20 to 60 million and large size construction project (>60 Million SR). The study has considered project with construction cost more than 3.5 million SR. The Figure 6 demonstrates the type of project in the public sector with the cost of projects awarded during 2006-2016 according to the project's construction costs, i.e. small, medium and large size projects. In education sector has large number of small size construction projects during the 2006-2016 whereas the road and transport sector has large size construction projects due to cost involved in these sectors.

Figure 7 shows the project contract cost relationship with extent of delay rate % for general directorate of education projects and general directorate for Asir municipality

projects. The figure shows that in education sectors projects, the extent of delay rate 94.5% for the project cost range of 3.50 to 5.50 million whereas in the municipality sector projects for similar cost range, the extent of delay rate is 61.90%. However, when the cost range is increased to 9.51 to 13.50 million, the extent of delay rate in education sector is 26.48% whereas the extent of delay rate in municipality sector is 64.83%. It is inferred that with lower cost range of projects, the extent of delay rate in education sector projects are more than the extent of delay rate in municipality sector projects. From figure 6, it is also inferred that the projects with lower and higher cost range, the extent of delay rate is higher as compare to medium cost range projects with different type of public sector.

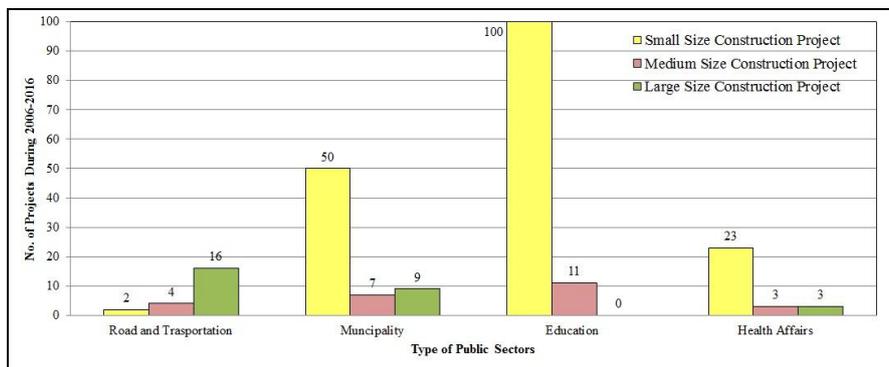


Figure 6. Type of public sector with the number of project awarded during 2006-2016

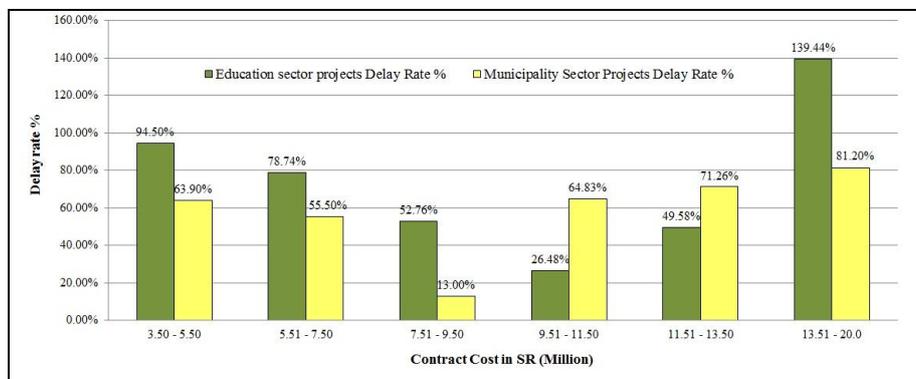


Figure 7. The project contract cost relationship with extent of delay rate % for education sector projects and municipality projects

C. Statistical analysis of Cost and Extent of Delays in Public Sector Construction Projects

Using statistical parameters, the cost and extent of delays in public sector construction projects is evaluated. Table 6 demonstrates the mean, minimum, maximum, std. dev. assessment of the cost and extent of the delay rate in the public sectors mentioned above. The table concluded that the delay rate (112%) is higher in the large-size project in the Aseer Municipality project, but the lower mean delay rate observed in small-size projects.

The analysis of General Directorate of Roads and Transport project revealed that the mean extent of delay rate is higher in small size project while the lowest found over medium size projects. It may be concluded that the

municipality sector project are delayed when they are of large size however in the road and transport sector project are delayed when they are of small size. In this paragraph we discussed the relationship between the projects completed on time with projects completed with delay in different public sectors projects awarded during 2006-2016. The outcome (Figure 8a) indicates that the project in the road and transport sector has a 100% projects delay followed by health affairs (93%), while in the municipality sector has a lower percentage (58%) of projects delay.

Figure 8b shows that the mean extent of delay rate is the highest in health affairs sector project (262%) followed by road and transport sector (71%), municipality sector project (62%) and education sector project (59%).

The linear regression coefficient has been performed to know the dependency between contractual project duration and actual project duration. Figure 9 shows that the moderate positive ($R^2 = 0.470$) relationship exist between contractual project duration and actual project duration in municipality sector project followed by road and transport sector projects ($R^2 = 0.278$), with least variation near the regression line. Among the public sectors projects, there is no linear

coefficient found for Health affairs and education sector project.

The extent of delay in public construction projects is revealed that the lower contract duration of the project have a higher delay rate, while projects with higher contract duration of the project have a lower delay rate. The present study provides solutions that may decrease the extent of delay problem in construction projects and will provide a better understanding of the delay extent in Saudi Arabia. It is suggested that will be monitored before the beginning of the project and during the construction of the project to reach the roots of the problem of delay in the construction projects.

Table 6. Statistical analysis of Cost and Extent of Delays in Public Sector Construction Projects

Public Sector	Parameters	Small Size Construction Projects (3.5 to 20 million)		Medium Size Construction Projects (20 to 60 million)		Large Size Construction Projects (>60 Million)	
		No. of Project		No. of Project		No. of Project	
Municipality project		50		7		9	
	Delay Rate		Cost	Delay Rate	Cost	Delay Rate	Cost
	Mean	53.92%	8.60	58.71%	32.12	112.22%	85.96
	Min	0.00%	3.65	0.00%	20.86	0.00%	66.17
	Max	349.00%	19.84	333.00%	50.08	341.00%	108.72
Std. Dev	0.837	4.772	1.227	10.99	1.067	16.37	
General Directorate of Education		100		11		0	
	Delay Rate		Cost	Delay Rate	Cost	Delay Rate	Cost
	Mean	62.76%	8.57	21.17%	23.58	-	-
	Min	0.00%	3.54	4.47%	20.31	-	-
	Max	322.80%	14.50	43.23%	27.57	-	-
Std. Dev	0.774	2.832	0.127	2.666	-	-	
General Directorate of Roads and Transport		2		4		16	
	Delay Rate		Cost	Delay Rate	Cost	Delay Rate	Cost
	Mean	186.47%	13.60	51.02%	42.54	61.48%	118.04
	Min	24.31%	9.20	27.61%	30.00	4.48%	60.07
	Max	348.63%	18.00	95.67%	55.00	144.58%	226.92
Std. Dev	2.293	6.223	0.306	11.269	0.434	56.73	
General Directorate of the Health Affairs		23		3		3	
	Delay Rate		Cost	Delay Rate	Cost	Delay Rate	Cost
	Mean	309%	3.94	59%	32.82	100%	154.99
	Min	0.00%	3.50	23%	23.85	0.00%	110.50
	Max	592%	13.00	122%	50.00	247%	216.00
Std. Dev	1.604	2.024	0.550	14.89	1.299	54.651	

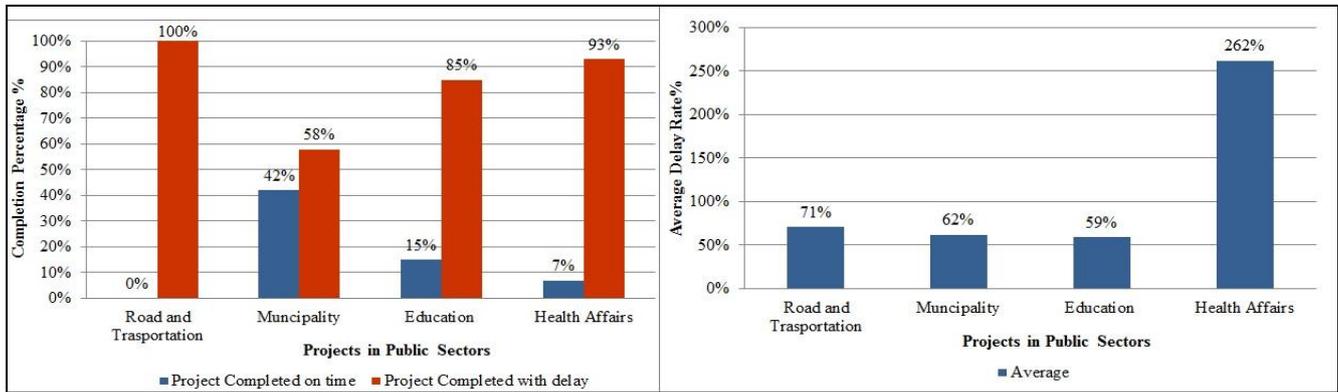


Fig. 8. (a) the relationship between the projects completed on time with projects completed with delay and (b) mean extent of delay rate in different public sectors projects

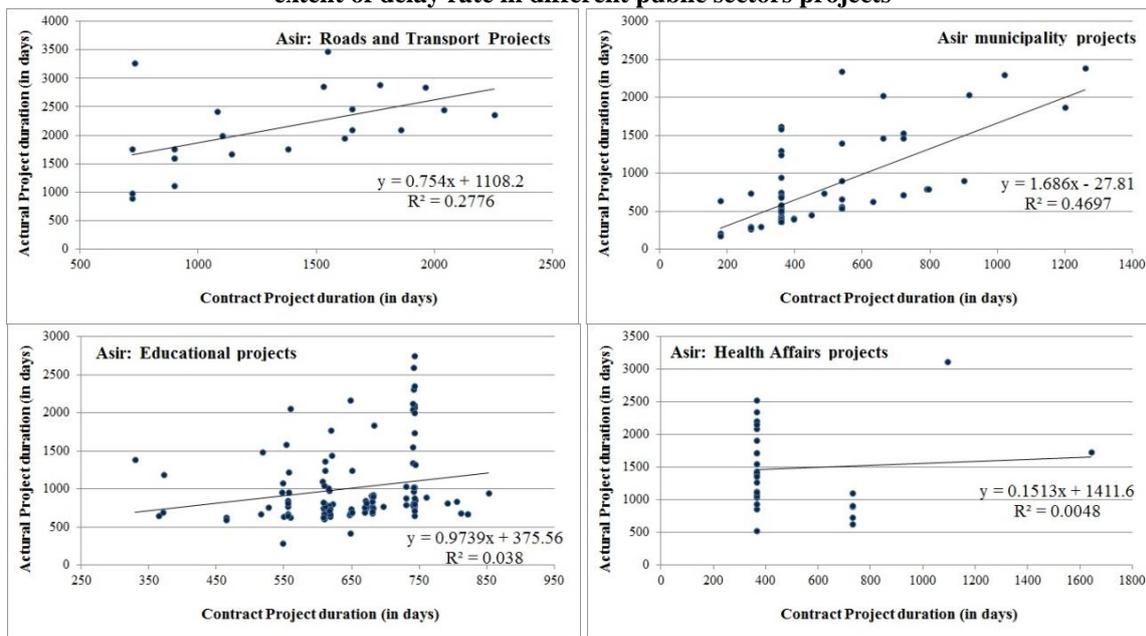


Figure 9. Linear coefficient between contract project duration and actual project duration of public sectors projects during 2006-2016

V. CONCLUSIONS

The objective of this study is to evaluate the cost and extent of delays in public sector construction projects in Aseer, KSA and identifying whether the delay extent is natural or large compared to other areas. The methodology for the project delays studies is as follows, collection of projects information from the main sources, classifying them according to the project size limits, analyzing the available data, knowing the delay size and cost relationship of every sector. The comparison of the delays extent of the different projects are also carried out to identify the most delayed projects as well as those completed on time using the statistical analysis. The majority of the projects in Municipality sector of Aseer region are of small size project with construction duration range 12 – 34 months while most of the Road and transport sector projects are of large size project with construction duration range 24 – 30 months. The 100 percentage projects in Road and transport sector are delayed and extent of delay rate varying from about 5% to 350%. The 58 percent project in Municipality sector are not completed in stipulated time and extent of delay rate vary from about 4.0% to 349%. The evaluation study of cost and extent of delay rate revealed that projects with lower contract

duration of the project have a higher delay rate, while projects with higher contract duration of the project have a lower delay rate. The study is also inferred that the projects with lower and higher cost range, the extent of delay rate is higher as compare to medium cost range projects with different type of public sector. Analysis of delays shows that the majority of construction projects in the Aseer region have exceeded their time and the most significant delay among government sectors was the Directorate-General for Health Affairs. The extent of delay in construction project decreases with the progress of country. Based on the linear regression coefficient it found that the moderate positive ($R^2 = 0.470$) relationship exist between contractual project duration and actual project duration in municipality sector project followed by road and transport sector projects. Among the public sectors projects, there is no linear coefficient found for Health affairs and education sector project. The future implication of this study is to provide the solutions that may decrease the extent of delay problem in construction projects and will assist in better understanding of the delay extent in Saudi Arabia.

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