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## Causes and Monitoring of Delays and Cost Overrun in Construction Projects in Pakistan

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**Abstract**—Cost overrun and delay are very frequent phenomenon and are generally associated with nearly all projects in the world especially in developing countries. Generally, 71 percent of projects suffer from cost/time overrun in the world with an average cost overrun of 43%. In this study, 25 factors causing cost and time overrun were considered. The ranking of 25 factors causing cost overrun and delay in construction projects made on the basis of mean value of impact which was determined from 65 project data file and 65 executive's opinion on structured instrument, giving equal weightage to both the values. The factor of "Inconsistent Cash Flow" was the most significant factor with impact value of 7.78 in severe category and "Weather Severity" was the least significant factor with impact value of 3.40 in moderate category. In this study, 65 projects of different departments executed by Frontier Works Organization (FWO) were considered which include 48 completed and 17 running projects. FWO is one of the biggest construction organizations of Pakistan with a financial worth of Rs.36 billions and annual turnover of Rs.22 Billions working all over Pakistan and abroad. Out of 65 selected projects, 38 were roads projects, 12 infrastructure and development projects (private sector) and 15 projects of Government Departments (Railway, WAPDA, Structures, Irrigation/ Power, Airports &Telecomm). Out of 65 projects, only 7 projects were completed within budget thus showing that 90 % projects are suffering from cost variation including 74% projects over running cost and 15% projects under running cost due to scope reduction. Only 2 projects were completed on planned schedule thus showing that 97% of projects were suffering from delay. Overall average cost overrun was 28.27% with an average delay of 2.1 years per project. The highest cost overrun has been observed in projects of Government Departments i.e. 37.59% and highest delay per projects was observed in roads projects i.e. 2.3 years per project. The public/private organizations, regulatory bodies, financing institutions and government should control the financing, planning, management and technical aspects of projects to minimize the cost/time overrun.

**Keywords:** - World construction industry, project management, causes of cost/time overrun, impact ranging/ranking, earned value analysis.

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### I. INTRODUCTION

The construction industry is an industry which transforms the shadow images of living means generated in human minds into physical reality. It adds value to social living standards, places for entertainment, ways of communication, factories for manufacturing, structures for power generation, offices, residential buildings, hospitals, laboratories, universities, irrigation channels, hydraulic structures and every thing which facilitates human beings and adds value to advanced living and modern societies. Advancements in construction are emerging due to enhanced human needs, necessity of change in outlook and performance of living means, development of new social set ups, establishment of new trends in social standards and generation of innovative ideas in human minds. Construction industry is very a dynamic industry which is susceptible to changes every moment and for every new endeavour. It can rightly be considered as the most dynamic and most booming industry in the world with unfathomable scope and indefinite innovation. Construction industry implies the advancement in the world and dictates the economic trend as it contributes almost 10% of global GDP and employs around 6-7% of manpower. A country is well known by its modern infrastructure and historical architect contributed by a solid and progressive construction sector [1]. Cost and time overruns are considered as core issues in every construction project which can cause the budget/ schedule/ scope creep. Understanding the specific causes of cost and time overruns due to design or changed conditions can help control cost and time extension on projects. They may be related to external or internal factors that may cause the construction of a project to time and cost overrun [2]. Cost overrun is a glaring issue in project management in developing and developed countries alike. The trend is more severe in developing countries where these overruns sometimes exceeds manifold [3]. These overruns/ creeps not only impact the pace of projects but also hampered the economic growth of country [4]. Construction activity requires major investment outlays in most developing countries; therefore, their timely completion is of paramount importance [5]. The study identifies that most

delayed projects also experience cost overruns. An unusual cost and schedule variation are generally part and parcel in projects. Further we identify the root causes of project delay and cost overrun [6].

**A. Problem Statement**

The construction industry is one of the major economic growth sectors in Pakistan which consumes a major chunk of annual budget allocations and heavy private investment along with setting the pace of nation building and economic development. Moreover, hundreds of big/small firms and millions of employees are related to this industry. Any failure, cost overrun and over scheduling will affect all tiers of life and business. There is a need to establish the root causes of cost overrun and delays in construction projects in Pakistan by analyzing projects and expert opinions of different departments along with recommendations to avoid these factors to timely complete the projects within allocated budgets.

**B. Objective of Study**

The main objective of this study is to determine and analyse the causes of cost overrun and delays in construction projects in Pakistan and recommending ways to address these factors during project planning/ execution/ financing. The purpose is to identify the primary causes of delays and cost overrun factor and ascertain their impact in causing time/cost overruns and then ranking these factors as per their severity impact. To determine the application of earned value analysis as monitoring tool to identify/monitor the delays and cost overrun in ongoing construction projects. Finally, to make certain recommendations to avoid these factors of cost overrun to complete the projects within budget and with efficient financial control.

**C. Significance of Research**

Construction industry is a progressive industry and grew by around 16% in last decade, driven primarily by increased state-spending on infrastructure development specifically under China Pakistan Economic Corridor CPEC Projects like road construction (coastal and inter-provincial highways/ motorways), power generation plants, hydropower projects and dams, Mass Transit projects like Metro Bus and Orange Line Train projects, airports and Gwadar Seaport projects and reconstruction work in the earth quake-affected areas but almost 90% projects overrunning the cost and schedule [7]. This study will establish the causes of cost overrun and delays in construction projects in Pakistan by analyzing projects and expert opinions of different departments along with recommendations to avoid these factors to timely complete the projects within allocated budget. Avoiding the causes of cost overrun and delays identified in this study will result in more development by doing more projects instead of expending more time and finances on same projects, more job opportunities and no closure and bankruptcies on economic grounds by construction firms.

**D. Research Design and Methodology**

A logical research methodology has been adopted starting from exploring the background of subject, thorough literature review, data collection tools preparation/validation, questionnaire design/validation, data collection/validation, analysis of data collected, earned value analysis of ongoing construction projects and finally making the recommendations and conclusions. The financial data of 65 construction projects of different public and private organizations have been collected and it has been analysed on a check list of 25 factors of cost overrun in the light of collected data, executer's experience and opinion of the executives in construction field giving equal weightage to both the values of project data file and executive opinions. Minimum worth of projects is Rs.30 million. Projects selected from the last 10 years period from 2000-2010. Severity impact calculated on the scale of 1 to 10 giving score 1 to the least significant factors and a score of 10 to most significant factors generating cost overrun in projects to rank the severity of factors ranging from mild (1-3), moderate (>3-6) to severe (>6-10). The mean of two opinions has been taken as the number to rank the impact of the factors from 1-25. Impact of each factor was calculated by simple calculation:

$$I = \Sigma (F)/N$$

Where I = Severity Impact of each factor,

F = Factor Severity,

N = Total number of projects

**E. Research Questions**

The study provided the answers of following questions:

- What is the status of world and Pakistani construction industry?
- What is cost and schedule creep/ overrun in construction projects?
- The historical examples of delay and cost overrun in the world;
- What are the causes/classification of delay and cost overrun in construction projects in Pakistan?
- What is the severity impact of causes of delay/cost overrun factors?
- What is the ranking of cost/time overrun factors based on their severity impact?

- How can the early warning and monitoring of delay and cost overrun be carried out in construction projects using earned value analysis?

## II. LITERATURE REVIEW

### A. *World Construction Industry*

The statistics of Economy Watch (2019) show World Construction Industry is around a US\$15 trillion industry and one of the mega growth sectors having more than 10% contribution to global GDP, 6-7% labor employment, bulk consumer of energy and resources and 10-12 % emitter of greenhouse gases [8]. Pakistani construction sector has displayed impressive growth of 9% in first decade of 2000 but reduced in second decade due to economic crises. However, multibillion-dollar Chinese investment in CPEC and allocation of around Rs. 2000 Billion in Public Sector Development Projects by Pakistan Government and private sectors has given it a zealous impetus. The statistics showing different aspects of construction industry of different countries of the world are given in Table 2.1.

**TABLE 2.1: World Construction Industry Statistics [9]**

Construction Industry	World	USA	UK	INDIA	CHINA	PAKISTAN
Contribution to GDP %AGE	10	9	8	4.6	14	2.52
Growth rate %	9	6.5	6	8	11	9
Financial Allocation 2019-2020	\$15 Trillion	\$825 billion	£184 billion	\$60 Billion	\$586 billion	\$7.5 Billions
Workforce Employment %	7	6	4	16	11	6
Consumption of energy	40%	-	-	-	-	-

### B. *Evolution of Construction Engineering*

The construction industry has its starting evidence since 10000 BC in prehistory period and has passed through Egyptian pyramids, Roman and Greek empires to modern construction and now it is passing in Nano Technology age [10].

### C. *Global Competitiveness Statistics of Infrastructure Development*

Construction industry has revolutionized the living standards, transportation means, irrigation systems, water reservoirs, construction in sea; desert, underground, snowy arctic and in mountains. The introduction and collaboration of science and technology with state of the art project planning/monitoring techniques, usage of innovative structures, new materials, huge mechanization, revolution in electromagnet, information technology, planning /monitoring/ designing software, monitoring techniques and dedicated/skillful control of construction projects have changed the entire world for human beings only in the last few years. The infrastructure development is considered to be the 2<sup>nd</sup> pillar in assessing the development of the countries of the world as determined by World Economic Forum. The infrastructure development pillar is calculated on seven elements mainly concerning with construction sector. The statistics showing comparison of different countries on infrastructure development is shown in Table 2.2.

**Table 2.2: Comparison of Infrastructure Development Competitive Statistics [11]**

Competitiveness Element	Pakistan	Turkey	UAE	India	China	Japan	USA
Quality of overall infrastructure	87	62	11	89	66	29	14
<b>Competitiveness Pillars used to calculate overall infrastructure</b>	<b>Pakistan</b>	<b>Turkey</b>	<b>UAE</b>	<b>India</b>	<b>China</b>	<b>Japan</b>	<b>USA</b>
Quality of roads	65	48	7	89	50	42	11
Quality of railroad infrastructure	51	63	-	20	27	84	17
Quality of port infrastructure	73	78	7	90	61	52	13
Quality of air transport infrastructure	76	54	3	65	80	33	20
Available seat kilometers	48	24	11	10	2	62	1
Quality of electricity supply	124	84	16	106	61	35	17

**D. Critical Success Factors in Construction Projects**

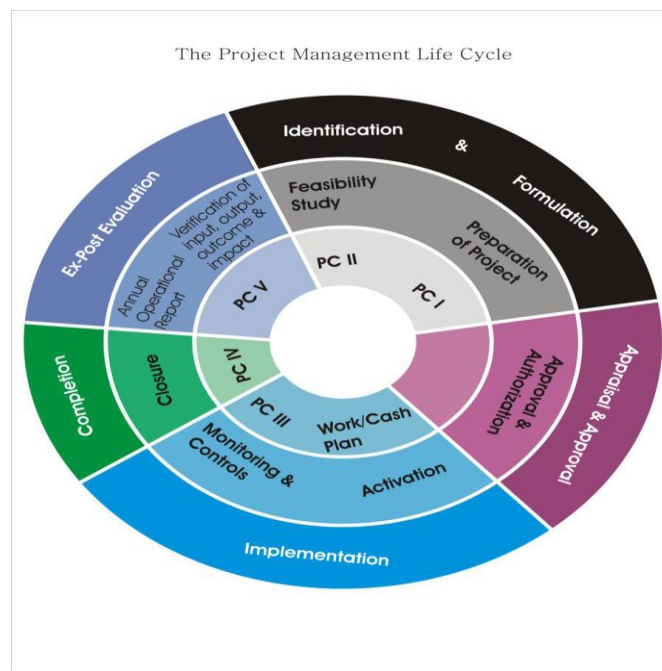
A project life cycle comprises many milestones and critical factors especially affecting the critical path environment and successful completion of projects. success than others. These factors can be termed as critical success factors (CSFs). Rockart (1982) defined and is as those factors predicting success of projects some of which have been shown in Table 2.3.

**Table 2.3: Critical Success Factors in Construction Projects [14]**

Project Success Factors	
Timely Decision	Swift Modifications
Expert Team	Professional Monitoring
Efficient financing and budgeting	Project Planning
Contractor experience	Project life cycle Management
Customer Requirements	Swift Decisions by Clients and Consultants

**E. Project Management in Pakistan**

The project management life cycle with specific reference to Pakistan is illustrated in Fig 2.2. It shows that a project is perceived by Public sector and initial planning is done as the feasibility report/ project cycle PC 1&2. The project is then approved by competent authority and funds are released and monitoring mechanism is constituted through a consultant who supervise the project till implementation of client requirements and completion of project and also transform any modifications/ cost/ scope creep as PC3 progress report. After completion of project final details of are summarized as PC4 project closure report having the actual figures on the closure. Any modifications and financial/ scope modifications are evaluated and then presented as PC5 report and ex-post facto sanction of such modified effects are again given by the approving authority. All these steps make part of a project management life cycle in Pakistan Public sector projects [15]:



**Figure 2.2 Project Management Life Cycle [15]**

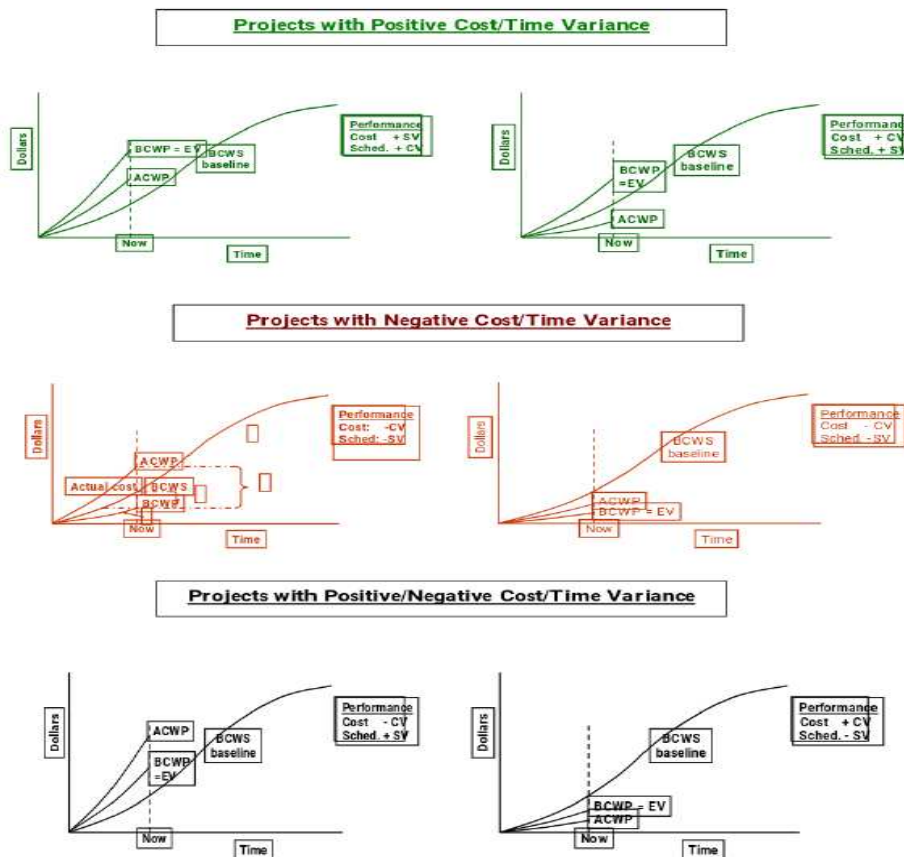
**F. Cost Overrun and Delays in Construction Projects**

It has been observed that projects often lack in schedule, gain financial negativity and sometimes fully collapse because of number of cost and time overrun factors [3]. These factors can be arisen by client/ consultant/ project manager or contractor [2]. Pakistan is also facing these issues in its major projects due to political uncertainty, frequent changes in development/projects plans/policies, departmental corruption/kickbacks, and fluctuation in prices of construction materials, late provision of construction design/drawings, inappropriate cost estimation, additional works, improper planning, late of acquisition of land/site, removal/relaying of existing/new services, social and religious impediments, non availability of labour and materials, late payments and project financing, security and law & order issues, weather severity, incompetent managers/consultants and unsupportive government policies etc. Cashflow can be termed as the lifeline of a project and its overrun (increase between completion cost and initial cost) can be fatal outcome hampering the successful completion [16]. According to one very comprehensive research made on cost

overruns in global construction by Hackney and Humphries (2001), it was found that 90 percent of projects suffered more than 50% cost creep in major projects in 5 continents in the last 7 decades. The Sydney Opera House suffered by 14 times cost overrun and 10 years delay, the cost creep of Boston's Big Dig was 2.75 times with about 12 years' time overrun. The Channel Tunnel project crept by 1.8 times the initial cost and considerable double the delays [17]. The cost creeping in mega projects is not only impactful for the projects but jeopardize the economic outlook of a country too [4]. The projects are combination of set of activities and when one-activity experiences a delay due to a late start or late finish, the succeeding activities will also experience a late start and cause the project extra time and money [18]. The delays in projects can be because of internal issues of modifications in design/ scope by client, defected design by consultant or wrong/ delayed execution by contractor or because of external issues like non removal of services, land acquisition, weather conditions or force majeure etc. Some issues are critical and can have compensation by client in cost/ time or vice versa [19]. Cash flow management is the responsibility of client and generally paid as 10-20 % advance as mobilization, then interim bill payments followed by final bill and release of security after completion of maintenance period. Any issue in cash flow will hamper the progress, suffer the delay and will result in increased cost due to increase in overhead charges, labor and material cost [20].

**G. Earned Value Analysis as Monitoring Tool for Running Projects**

EVA is a project performance measurement technique developed by US Armed forces that integrates scope, time and cost data. Earned Value Analysis compares the current project status with the original (baseline) plan to know how well the project is going on. It computes several performance metrics for individual activities and for the entire project. It focuses on cost and schedule performance. It's a useful tool for project control. Earned value concept combines cost reporting & aggregate performance reporting into one comprehensive chart. We can ascertain a project by using earned value analysis whether it is under-budget and ahead of schedule, over-budget and ahead of schedule, on budget and ahead of schedule, under-budget and behind schedule, over-budget and behind schedule, on budget and behind schedule. The graphical representation is shown in figure 2.3 [21].



**Figure 2.3: Graphical Representation of Outcomes of Earned Value Analysis [21]**

**H. Historical Examples of Cost and Time Overrun in Famous Projects of The World**

Some of the famous construction projects of the world with huge cost overrun and delay are shown in Table 2.4. These examples show that delays and cost overrun in construction projects is common all over the world both in developed and developing countries.

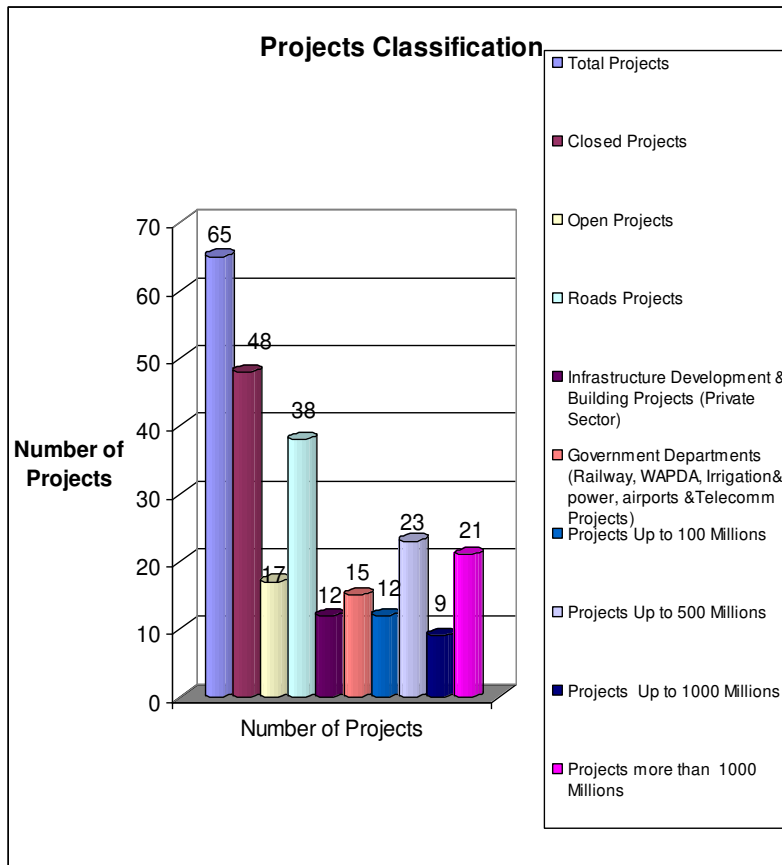
**Table 2.4: Famous Projects with Huge Cost/Time Overrun**

Name of Project	Cost Overrun Million	Delay (Years)
The Big Dig or Central Artery/Tunnel Project USA <sup>[22]</sup>	\$11000	12
The Sydney Opera House <sup>[23]</sup>	\$95	10
The Channel Tunnel <sup>[24]</sup>	£ 2050	18
The Scottish Parliament Building <sup>[25]</sup>	£374	3
The Olympic Stadium Canada <sup>[26]</sup>	C\$791	11
The Holland’s Tunnel <sup>[27]</sup>	SEK 9000	20
Denver International Airport <sup>[28]</sup>	\$2000	2
Eastern Span Replacement Of The San Francisco Oakland Bay Bridge <sup>[29]</sup>	\$4100 million	6
Ghazi Barotha Hydropower Project Pakistan <sup>[30]</sup>	Rs 38000	6

**III. RESULTS AND DISCUSSION**

**A. Data Collection**

For the purpose of this research work, 65 constructions projects of different departments have been selected executed by Frontier Works Organization FWO (A renowned construction organization of Pakistan). Moreover, causes of cost/time overrun in each project have been documented based upon project execution history and experience/opinion of project executers. Details of these projects basing on their nature of work and cost are shown in figure 3.1. Basing on the data collected for 65 construction projects and discussion with the projects executers, the checklist of 25 major factors has been established which has been used to get opinion of 65 executives concerned with construction projects in different construction organizations. The categories of executives who were interviewed on predetermined causes of cost/time over runs in construction projects comprise the client departments, executing/contractor’s organizations and consultants including highways, building and heavy engineering projects.



**Figure 3.1: Detail/Classification of Projects for Analysis and Data Collection**

**B. Factors Causing Cost Overrun and Delay in Construction Projects in Pakistan and Their Impact**

The financial data of 65 construction projects of different public and private organizations have been collected and it has been analysed on a check list of 25 factors of cost overrun in the light of collected data, executer’s experience and opinion of the 65 executives in construction field giving equal weighting to both the values of project data file and executive opinions. Severity impact calculated on the scale of 1 to 10 giving score 1 to the least significant factors and a score of 10 to most significant factors generating cost overrun in projects to rank the severity of factors ranging from mild (1-3), moderate (>3-6) to severe (>6-10). The mean of two opinions has been taken as the number to rank the impact of the factors from 1-25. Ranking and impact ranging of 25 factors of cost/time overrun in construction projects in Pakistan are given in Table 3.1 and in Figure 3.2. The factor of “Inconsistent Cash Flow” is the top factor with impact value of 7.78 in severe category and Weather Severity is the least factor with impact value of 3.40 in moderate category. Only three factors got severity impact more than six to fall in severe category and the remaining factors lie in moderate impact category.

**Table 3.1: Ranking and Impact Ranging of Cost/Time Overrun Factors**

Code	Factors Causing Cost Overrun	Mean Impact	Impact Category	Ranking
A	Inconsistent Cash Flow	7.78	Severe	1
B	Inappropriate Cost and Time Estimation	7.57	Severe	2
C	Deficiencies In Project Planning	6.04	Severe	3
D	Consultant/Monitoring Staff	5.94	Moderate	4
E	Additional Work Because Of Design/Scope	5.64	Moderate	5
F	Late/ Incomplete Provision of Drawing	5.62	Moderate	6
G	Delay and increased cost in Land Acquisition	5.54	Moderate	7
H	Improper Project Financing	5.53	Moderate	8
I	Poor Financial Control	5.22	Moderate	9
J	Fraud, Kickbacks, Corruption	5.21	Moderate	10
K	Frequent Design Changes	5.06	Moderate	11
L	Shifting Of Existing Services	5.05	Moderate	12
M	Low Cost Bidding Mechanism	4.91	Moderate	13
N	Inconsistent Government Policies	4.90	Moderate	14
O	Cost / Availability of Construction Material	4.45	Moderate	15
P	Poor Project/ Site Monitoring	4.43	Moderate	16
Q	Site Location/Remote Areas	4.30	Moderate	17
R	Cost and Non-Availability of Labor	4.24	Moderate	18
S	Cost / Availability of Construction Machinery	4.23	Moderate	19
T	Wastage on Site	4.12	Moderate	20
U	Inappropriate Contracts	4.11	Moderate	21
V	Litigation with Client, contractors & people	4.10	Moderate	22
W	Law & Order and Security Situation	3.84	Moderate	23
X	Stealing on Site	3.44	Moderate	24
Y	Weather Severity	3.40	Moderate	25



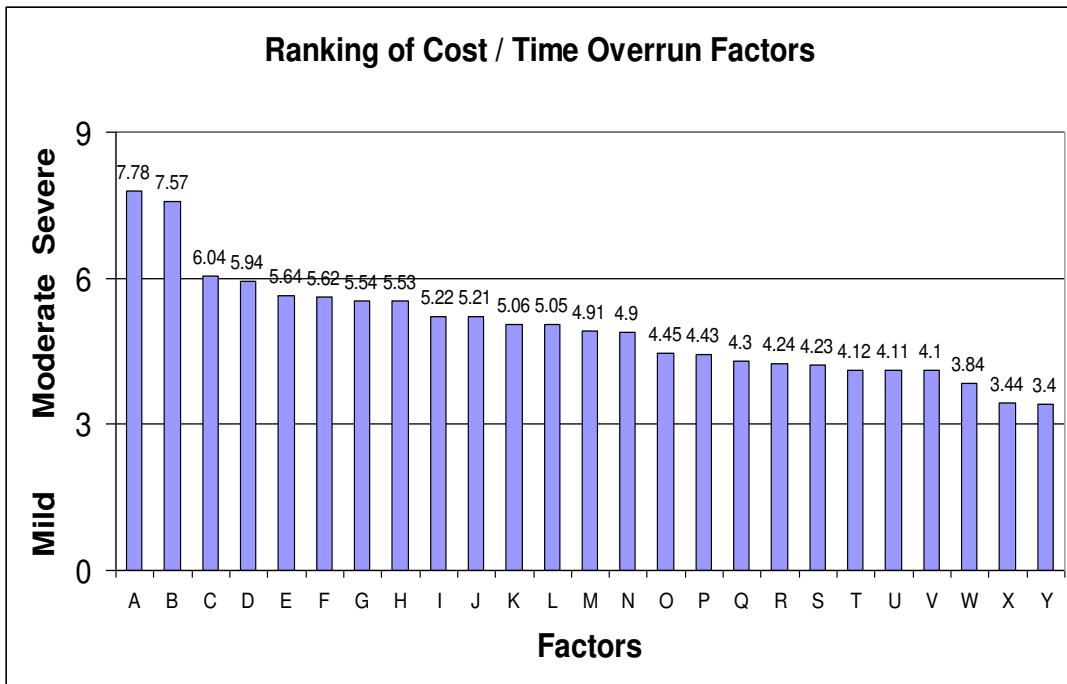


Figure 3.2 Ranking/Impact Ranging of Factors Causing Delay and Cost Overrun

**C. Classification of Major Factors Causing Cost Overrun and Delay**

All the factors of cost overrun were classified into five major factors which are as under. Classification of major factors and their ranking has been shown in Figure 3.3. Factors caused by financial impacts are on number 1 and management/condition factors are on number 5 to cause cost/time overrun in construction projects in Pakistan.

- Factors of Cost Overrun in Planning Phase  
Factors in this category are the ones which are considered in conception and development phase of projects.
- Factors of Cost Overrun in Execution Phase  
Factors in this category are the ones which are considered in execution and termination phase of projects.
- Factors of Cost Overrun Due to Financial Aspects  
These are the factors which are caused due to cash flow, financing of and financial control projects.
- Factors of Cost Overrun Due to Consultants/ Monitoring Staff  
These are the factors caused by incompetency and inadequacy of consultant and monitoring staff during execution of projects.
- Management and Conditions Factors of Cost Overrun  
These are miscellaneous management and conditions factors which include wastage and embezzlement, remote areas, law and order conditions, litigation and dispute resolution etc.

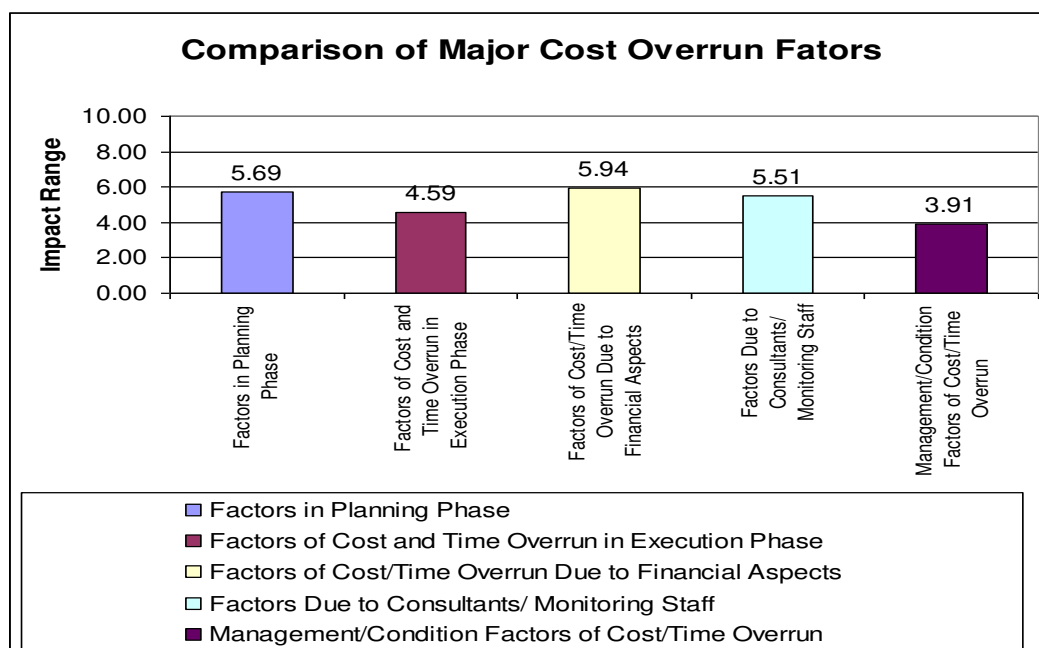


Figure 3.3 Comparisons, Classification and Severity Impact of Major Cost/Time Overrun Factors

**D. Major Findings of Research**

In this study a total of 65 projects have been considered comprising 48 completed and 17 running projects, out of 65 projects 38 are roads projects (National Highway Authority), 12 infrastructure and development projects (Private sector) and 15 projects of other government departments (Railway, WAPDA, Structures, Irrigation/ Power, Airports &Telecomm Projects). Out of 65 projects only 7 projects have not suffered from cost overrun thus showing that 90% of projects are suffering from cost variation including 48 projects over running cost and 15 projects under running cost. Only 2 projects have been completed on planned schedule thus showing that 97% of projects are suffering from delay. Overall average cost overrun is 28.3% with an average delay of 2.1 years per project. The highest cost overrun has been observed in projects of Government departments (Railway, WAPDA, Structures, Irrigation/ Power, Airports &Telecomm Projects) i.e. 37.6% and highest delay per projects has been observed in roads projects @ 2.3 years per project. The lowest cost overrun is 4.2% and minimum delay observed is 1.8 years in private sector. Out of 65 projects 12 projects are of worth up to Rs.100 Millions, 23 projects of worth up to Rs.500 Millions, 9 projects of worth up to Rs.1000 Millions and 21 projects are of worth more than Rs.1000 Millions. The highest cost overrun has been observed in Projects up to 500 Million i.e. 35.7% and highest delay per project has been observed in projects more than 1000 Millions i.e. 3 years per project. The lowest cost overrun was observed in projects less than Rs.100 Millions i.e. 16% and least delay was observed in projects less than 500 million. Percentage Cost overrun and delay statistics found from this study in 65 construction projects are shown in Table 3.2.

**Table 3.2: Statistics of projects suffering Cost Overrun and Delay**

Projects Classification	%age Cost Overrun	%age of projects with cost overrun	%age of projects suffering from Delay	%age Delay
Total Projects	28%	74%	97%	124%
Closed Projects	16%	73%	97%	124%
Open Projects	41%	77%	100%	135%
Roads Projects	28%	82%	97%	135%
Infrastructure Development & Building Projects (Private Sector)	4%	58%	100%	95%
Government Departments (Railway, WAPDA, Irrigation& power, airports &Telecomm Projects)	38%	67%	93%	150%

Projects Up to PKR 100 Million	16%	83%	92%	150%
Projects Up to PKR 500 Million	36%	78%	91%	88%
Projects Up to PKR 1000 Millions	19%	67%	100%	175%
Projects more than PKR 1000 Millions	29%	67%	100%	136%

**E. Comparison/Trend of Cost Overrun and Delay in Construction Projects in Pakistan**

The highest rate of projects suffering from cost overrun was observed in roads projects i.e. 82% and in projects less than Rs. 100 million i.e. 83%. The highest cost overrun rate was observed in projects of government departments i.e. 37.59% and in projects less than Rs. 500 million i.e. 35.67% as shown in figure 3.4. Generally, more than 90% projects suffered from delay. The highest delay was observed in projects of government departments i.e. 150% and in projects up to Rs. 1000 million i.e. 175% as shown in Figure 3.5.

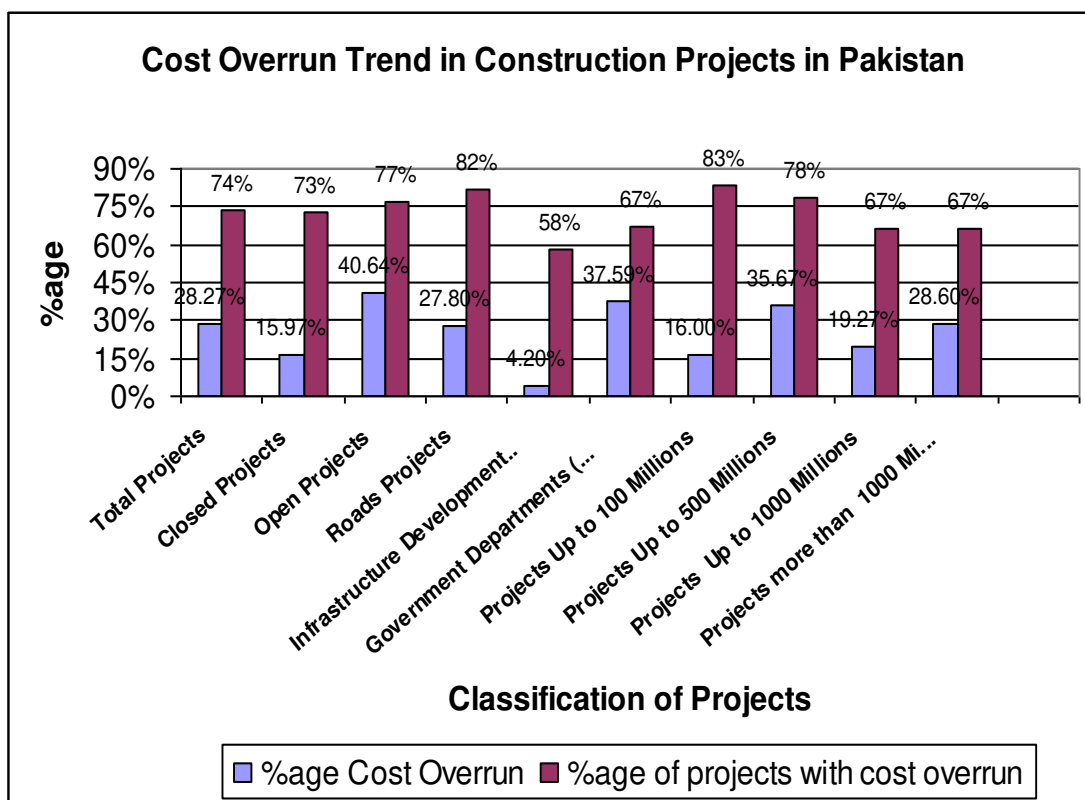


Figure 3.4 Comparison of Cost Overrun in Construction Projects in Pakistan

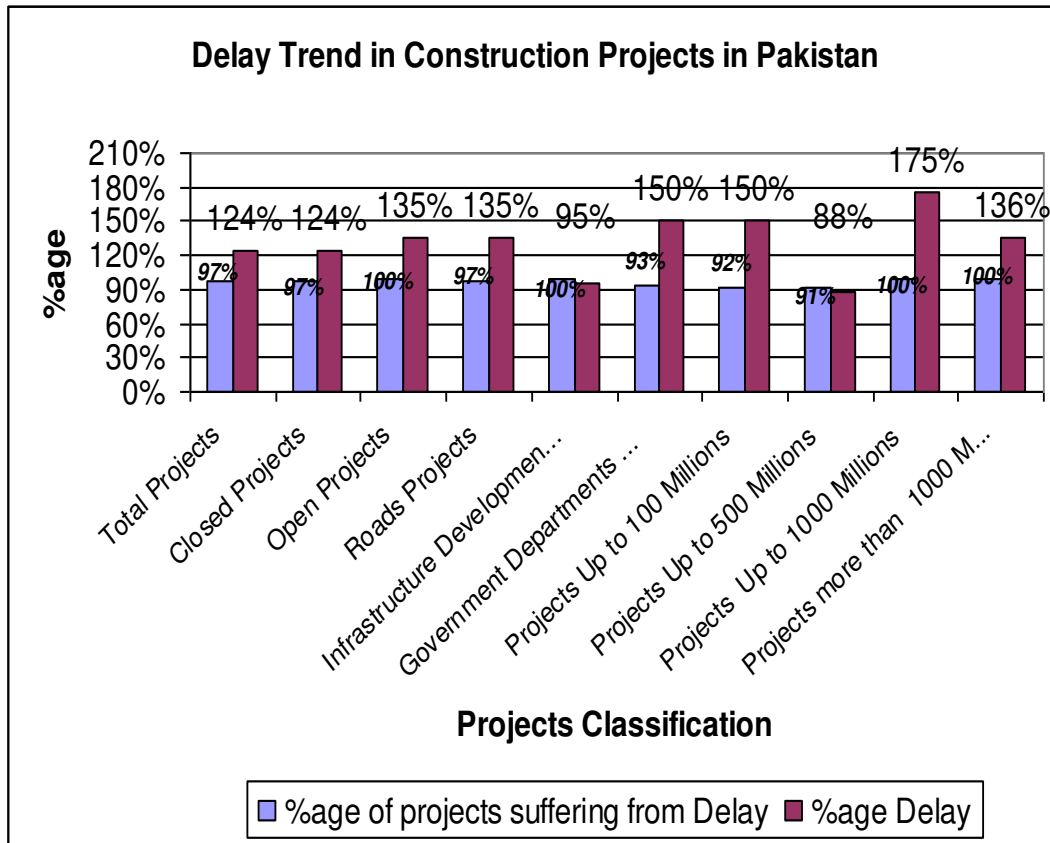


Figure 3.5 Comparison/Trend of Delay in Construction Projects in Pakistan

**F. Monitoring of Construction Projects Using Earned Value Analysis**

The earned value analysis is used to keep the record of project cost and time performance and can be used as a warning system to warn about the cost overrun and delay in the projects. It compares the current project status with the original (baseline) plan to know how well the project is progressing. Followings are the terms and formulas used in earned value analysis: - [21]

- ACWP = (Actual cost of work performed)
- BCWP (Budgeted cost of work performed)
- BCWS (Budgeted cost of work scheduled)
- STWP (scheduled time of work performed)
- ATWP (Actual time of work performed)
- CV (cost variance)  $CV = BCWP - ACWP$  (negative value means cost overrun)
- SV (schedule variance)  $SV = BCWP - BCWS$  (negative value means behind schedule)
- TV (Time variance)  $TV = STWP - ATWP$  (negative value means delay)
- BAC (Budgeted cost at completion) = Total cost of project
- CPI Cost Performance Index  $CPI = BCWP/ACWP$
- SPI Schedule Performance Index  $SPI = BCWP/BCWS$
- TPI Time Performance Index  $TPI = STWP/ATWP$
- A CPI / SPI / TPI that is less than 1 or 100 percent indicate problems
- ETC Estimated (remaining cost) To Completion =  $(BAC - BCWP) / CPI$
- EAC Estimated (Total Cost) At Completion  $EAC = ETC + ACWP$

Earned value analysis of 17 projects out of 65 projects considered for this study, has been carried out using the above-mentioned formulas and data collected for the projects. The analysis showed that 10 out of 17 projects have positive cost variance or CPI more than one thus showing that these projects have not exceeded the prescribed cost of work done as compared to the budgeted cost. All 17 projects are suffering from time overrun and they are behind schedule in terms of time and scheduled cost of work done as values of schedule and time variance are negative or values of schedule performance index and time performance index are less than one. All 17 projects will be suffering from cost overrun at the time of completion as the estimated cost to

completion ETC and estimated cost at completion EAC are more than the original cost of projects as shown in table 3.3. This analysis showed that all the running projects will be suffering from delay and cost overrun due to present political conditions and mainly due to financial crises/poor cash flow conditions in Pakistan.

**Table 3.3 Earned Value Analyses of Ongoing Projects**

Proj Code	ACWP	BCWP	BCWS	STWP	ATWP	CV	SV	TV	BAC	CPI	SPI	TPI	ETC	EAC
Can1	189.39	129.72	6657.2	2.00	3.00	-59.68	-6527.5	-1.00	6657.21	0.68	0.02	0.67	9530.66	9720.05
Rd1	468.15	422.12	1331.0	1.25	3.25	-46.03	-908.90	-2.00	1331.02	0.90	0.32	0.38	1008.02	1476.17
Rd2	439.93	363.96	779.59	1.00	2.00	-75.97	-415.62	-1.00	779.59	0.83	0.47	0.50	502.38	942.31
Rd3	1335.0	1267.5	1297.0	2.00	6.00	-67.50	-29.50	-4.00	1297.00	0.95	0.98	0.33	31.07	1366.07
Grd	362.33	310.50	374.84	2.00	5.00	-51.83	-64.34	-3.00	374.84	0.86	0.83	0.40	75.08	437.41
Rly	303.00	388.69	530.25	1.00	3.00	85.69	-141.56	-2.00	530.25	1.28	0.73	0.33	110.35	413.35
Rd4	754.40	790.00	1157.4	1.50	5.00	35.60	-367.41	-3.50	1157.41	1.05	0.68	0.30	350.85	1105.25
Rd5	1096.0	1102.0	2777.0	1.00	2.00	6.00	-1675.0	-1.00	2777.00	1.01	0.40	0.50	1665.88	2761.88
Rd6	111.00	128.83	262.00	0.75	1.75	17.83	-133.17	-1.00	262.00	1.16	0.49	0.43	114.74	225.74
Rd7	175.23	156.00	753.00	1.50	3.00	-19.23	-597.00	-1.50	753.00	0.89	0.21	0.50	670.59	845.82
Rd8	358.00	254.00	3000.0	1.25	4.00	-104.0	-2746.0	-2.75	3000.00	0.71	0.08	0.31	3870.35	4228.35
Rd9	873.23	876.24	1166.3	1.50	3.00	3.02	-290.12	-1.50	1166.36	1.00	0.75	0.50	289.12	1162.35
Rd10	7000.0	7187.0	8234.3	2.50	8.50	187.00	-1047.3	-6.00	8234.32	1.03	0.87	0.29	1020.07	8020.07
Can2	8950.7	9039.2	16794	4.00	9.00	88.52	-7755.1	-5.00	16794.30	1.01	0.54	0.44	7679.16	16629.8
Airp	79.00	79.50	680.00	1.00	1.25	0.50	-600.50	-0.25	680.00	1.01	0.12	0.80	596.72	675.72
Rd11	1433.4	1438.5	2269.7	3.00	4.00	5.17	-831.19	-1.00	2269.74	1.00	0.63	0.75	828.20	2261.59
Rd12	862.07	916.68	921.72	2.00	3.50	54.61	-5.04	-1.50	921.72	1.06	0.99	0.57	4.74	866.81

#### IV. CONCLUSION

A study of world construction industry was carried out taking into consideration some of the historical projects and 65 projects of different departments in Pakistan to assess the causes of cost overrun and delays in construction projects. The main conclusions are summarized below:

1. World Construction Industry is a major sector where cost overrun and delay occur in most of the projects and badly impacts the world economy especially in developing countries.
2. Factors caused by financial reasons are on number 1 and management/condition factors are on number 5 to cause cost/time overrun in construction projects in Pakistan. The factor of "Inconsistent Cash Flow" is the top factor with impact value of 7.8 in severe category and Weather Severity is the least factor with impact value of 3.4 in moderate category. Only three factors got severity impact more than six to fall in severe category and remaining factors lie in moderate impact category.
3. Out of 65 projects considered in this study, 90% of projects are suffering from cost variation. Only 2 projects have been completed on planned schedule thus showing that 97% of projects are suffering from delay. Overall average cost overrun is 28.3% with an average delay of 2.1 years per project.
4. The highest cost overrun has been observed in projects of Government departments i.e. 37.59% and highest delay per projects has been observed in roads projects @ 2.3 years per project.
5. The lowest cost overrun i.e. 4.2% and least delay i.e. 1.8 years were observed in private sector.
6. The highest cost overrun has been observed in Projects up to 500 Million i.e. 35.7% and highest delay per project has been observed in projects more than 1000 Million i.e. 3 years per project.
7. lack of management techniques and timely decision-making lead to a creeping project, therefore, a competent project management team with swift support from client and consultant throughout the project life cycle is the key to success.
8. The highest cost overrun has been observed in projects of government departments; therefore, government departments need incorporation of better project management practices free from political influences and financial malpractices.
9. Performance of private sector in construction industry is found better but need implementation of better project management for better results.
10. The highest cost overrun has been observed in Projects up to 500 Million i.e. 35.7% and highest delay per project has been observed in projects more than 1000 Millions i.e. 3 years per project. Therefore, a good supervision by a competent management team is even more essential for larger projects.
11. The earned value analysis can show the cost/ time status of running projects and may be employed by project managers as an essential monitoring tool to timely assess any delay and cost overrun due to poor cash flow or any other factor.

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