



**An Exploration of the Causes of Cost Overruns in Public
Sector Infrastructure Projects in the United Arab Emirates
(UAE): A Stakeholder Perspective**

استكشاف أسباب التجاوزات اللاحقة بتكاليف مشاريع البنية التحتية بالإمارات
العربية المتحدة:
من منظور مساهم

by

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**A dissertation submitted in fulfilment
of the requirements for the degree of
MSc PROJECT MANAGEMENT**

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Abstract

In this research paper, the light is shaded on cost overrun as one of the hot topics that is becoming commonly a phenomenal issue in the projects worldwide. In spite of the considerable developed knowledge in project management, cost overrun is inherently forming a part for the most of the infrastructure projects. Today, the degree of project's success is measured by being within the golden triangle of cost, scope and time. Therefore, this proposed dissertation is investigating the factors that cause costs to overrun in public sector infrastructure projects specifically in UAE from perspective of clients and contractors as well as consultants who are the main three stakeholders. An extensive literature review was demonstrated at the aim of studying the major factors causing costs to overrun in public sector infrastructure projects in UAE. Several causes of cost overrun were accordingly explored.

Quantitative research techniques were subsequently conducted as to collect data from the three key stakeholders according to their expertise in any of the public sector infrastructure projects in the UAE that come across the issue of cost overrun. The quantitative research approach investigation was done through the use of online questionnaire technique as to examine the relationship amongst the overrun issue pertains to project's costs and causes triggered cost overrun of public sector infrastructure projects in UAE. The analysis confirmed that the studied causes of cost overrun with its independent variables of (inadequate project management, funding problem, improper cost estimation, payment delay, poor tendering documents, inappropriate contractors selection, lack of contractors experience, contractors financing, frequent design changes during the construction, and poor material management) do correlate with cost overrun variable and **80.0%** of the change in the project cost overrun issue can be explicated via the variability of these studied causes of cost overrun.

According to the analysed data, a number of significant recommendations were suggested to be undertaken at the aim of minimising the issue of costs overrun accompanying with the public sector infrastructure projects. The suggested recommendations include the adoption of effective strategic planning along with the efficient management of communication undertaken amongst the entire project's stakeholders. Besides, engaging experienced and highly qualified contracts in addition to having proper advanced project planning and scheduling tools and charts would ensure a successful attainment of project's objectives. A constant control and measure of the overall project's progress was also recommended along with the integration of value management as to accomplish the best cost design options. A well documentation of project's designs prior to sharing them would enhance the performance of the employed contractors pertaining to the required material management too. All in all, the suggested recommendations if implemented would eliminate project cost overrun and enable projects to move towards successful completions.

تمهيد:

تتناول هذه الورقة البحثية تجاوزات التكاليف باعتبارها واحدة من أهم القضايا البارزة التي أصبحت تشكل ظاهرة مشتركة في جميع المشروعات في جميع أنحاء العالم. وعلى الرغم من توافر قدر كبير من المعرفة المتطورة فيما يتعلق بكيفية إدارة المشروع، فإن تجاوزات التكاليف تشكل في حد ذاتها جزءًا أساسيًا من مشاريع البنية التحتية. واليوم، تُقاس درجة نجاح المشروع عن طريق كونها داخل دائرة التكاليف والنطاق والوقت. ولذلك، فنتناول هذه الورقة المقترحة العوامل التي تتسبب في تجاوز التكاليف في مشاريع البنية التحتية الخاصة بالقطاع العام بالإمارات العربية المتحدة على وجه الخصوص من منظور ثلاثة مساهمين من العملاء والمتعاقدين والاستشاريين. وقد تم إجراء استعراض أدبي شامل بهدف دراسة الأسباب الرئيسية المتسببة في تجاوز التكاليف في مشاريع البنية التحتية الخاصة بالقطاع العام بالإمارات العربية المتحدة. وقد تم التحقيق في الأسباب المختلفة لهذا التجاوز، ثم عرض العلاقة بين تجاوزات التكاليف وأسبابها الرئيسية.

وأجريت تقنيات البحث الكمية لجمع البيانات من المساهمين المستهدفين أمثال (العملاء والاستشاريين والمتعاقدين) وفقًا لخبراتهم المهنية في أي من مشاريع البنية التحتية الخاصة بالقطاع العام في الإمارات العربية المتحدة فيما يتعلق بقضية تجاوزات التكاليف. وقد تم إجراء ما سبق باستخدام الاستبيان الإلكتروني لمحاولة دراسة العلاقة بين تجاوزات التكاليف وأسبابها الرئيسية الخاصة بمشاريع البنية التحتية للقطاع العام. وقد تبين أن الأسباب المدروسة لتجاوزات التكاليف مع متغيراتها المستقبلية (الإدارة غير الملائمة للمشروع ومشكلة التمويل والتقدير غير الدقيق للتكلفة وتأخر الدفع وضعف وثائق المناقصة والاختيار غير المناسب للمقاولين وقلة خبرة المقاولين وتمويل المقاولين والتغييرات المتكررة للتصميم أثناء عملية الإنشاء وضعف إدارة المواد) ترتبط مع متغير تجاوز التكاليف وأن 80% من هذا التباين في تجاوز التكاليف يمكن تفسيره من خلال تباين الأسباب المحددة والمدروسة لتجاوز التكاليف.

وطبقًا للبيانات التي تم تحليلها، فقد تم اقتراح عدد من التوصيات الهامة بهدف تقليل مخاطر تجاوزات التكاليف المصاحبة لمشاريع البنية التحتية للقطاع العام. وتشمل التوصيات المقترحة اعتماد التخطيط الاستراتيجي جنبًا إلى جنب مع الإدارة الفعالة للاتصالات التي يتم الاضطلاع بها بين المساهمين في المشروع بأكمله. وبالإضافة إلى ذلك، فإن الاندماج مع عقود تابعة لذوي الخبرة والمؤهلين وأيضًا امتلاك مخططات وأدوات متقدمة ومناسبة لتنسيق المشروع من شأنه أن يضمن إحرازًا ناجحًا لأهداف المشروع. وشملت التوصية أيضًا المراقبة المستمرة وقياس التقدم المحرز في المشروع بأكمله جنبًا إلى جنب مع إدماج إدارة القيمة وذلك لتحقيق أفضل الخيارات فيما يتعلق بتصميم التكلفة. ويعمل التوثيق الجيد لتصميمات المشروع قبل عرضها على

تعزير أداء المتعاقدين الذين تم توظيفهم فيما يتعلق بالإدارة المتطلبية للمواد أيضاً. وإجمالاً لما سبق ذكره، فإذا تم تنفيذ جميع التوصيات السابقة، سوف يقوم بمحو المخاطر المحتملة لتجاوزات التكاليف كما يمكن المشروعات من التقدم نحو إنجازات

محققة.

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1.0 Chapter 1: Introduction

UAE has been recently set the bar high for the prestigious development projects around the globe. It has been witnessed a significant jump in its infrastructure through a several massive infrastructure projects that targeted to offer UAE population facilities that match with twentieth-century level of living. Accordingly, numerous massive infrastructure projects have been executed in UAE. However; cost overrun was one of the common concerns in utmost of infrastructure projects because the overrun issue of project's costs has been proven to be a consistent feature of the infrastructure projects worldwide as showed in many studies (Le Hoai *et al.*, 2008). Based on the above, cost overrun should be regarded as a vital issue and a hot topic in the management of infrastructure projects in UAE. This research study will explore the utmost popular cost overrun factors in infrastructure UAE projects based on the perspective of clients and contractors as well as consultants who are the main three stakeholders of particularly infrastructure projects.

1.1 Research Agenda in projects' cost overrun issue in infrastructure projects

A great total of infrastructure projects worldwide experienced the problem of projects exceeding the planned costs, for that reason, project management scholars and researchers have emphasized on the subject of costs overrun (Brunes and Lind, 2014). A significant total of great profile examples as Sydney Opera House which its original cost estimation was AUD7.2 million; however, cost kept increasing to reach AUD102 million when the project was completed (Flyvbjerg, 2014), Scottish Parliament Building project that was 3 years behind the schedule and had more than 900% cost overrun; Australian Wembley Stadium project which had a dramatic cost overrun that exceeded 50% and experienced another one in Perth Arena where the actual

cost exceeded the cost baselines and had a cost overrun that was over its original cost value by three times (Love et al, 2011). Flyvbjerg illustrated that 90% of the infrastructure large-scale projects have cost overrun issues worldwide, and mentioned that the average cost overrun might range from 20.4% to 44.7%, in addition to that project cost overrun has been experienced in 20 nations and 5 continents (2009).

Researches have illustrated results from a study involving 250 huge infrastructure projects from various countries and time periods which are summarised in below points (Flyvbjerg et al, 2003):

- 86% of infrastructure projects faced the issue of cost excess from its planned estimated budgets and the percentage of cost overrun was averagely 28% in the examined projects.
- The overruns that had been experienced were the top in rail projects with 45% of cost overruns then in road projects with 20% overrun in cost.
- It was observed that project cost overruns were to some extent less significant in Europe when comparing to other geographic regions.
- Researches didn't build any performance trend for the cost overruns because the issue of project cost overrun is still experienced with the same trend since 30 years ago.

This observation has been validated by a recent Swedish study of all major infrastructure projects in Sweden which demonstrated that in the last decade all infrastructure projects had experienced major cost overruns (Lundman, 2011).

Scholars observed that cost overruns with all of the above mentioned results was shown to be a serious issue faced by most of the infrastructure projects since decades. Besides, no improvement have been witnessed in cost overrun over the past 70 years (Bruzelius, 2002). As a result, scholars considered cost overruns a hot topic in project management which as a result made it a

must for the scholars to investigate more in the factors of cost overruns issue in projects (Memon et al, 2011).

1.2 Projects and Infrastructure Projects

1.2.1 What is Project?

Project has been defined in a various way in literatures for example project has been defined in the PMBOK as an interim endeavor aimed to generate an incomparable result of for instance, a product or facility, even it includes an improvement in certain product or facility (PMI, 2013). Incomparable indicates that it has certain starting point as well as an ending point, while unique relates to the unique characteristics that differentiate the project deliverable from any comparable product and service (PMI, 2013). Projects are conceived as an enterprise that comprises a design or research and that have goals and objectives to be achieved (Stackpole, 2013). According to Hermarij and Bruce-Feijen, a project is a temporary organisation that has a purpose of delivering business product(s) based on a business agreement (2013). Kendrick (2009) added that a project is initiated to create unique results within a decided timeline and under defined constraints that comprise cost and resources along with other external circumstances. A project can also be illustrated as a set of tasks or activities that interconnect with each other and which should be performed in a specific time frame in order to deliver the desired result for which the project was initiated for. A project is unique, temporary and always initiated to achieve a predefined goal. Many projects might be assigned a limited time frame to deliver its desired output (Williams, 2011). The common part between all the above discussed definitions is that the project is agreed to be:

- Unique in its results.
- Temporary in nature, has a definite starting and ending point.

- Carried out to achieve a goal that is aligned with the organisation's strategic objectives.

PMBOK discussed the relationship among projects, programs and portfolios and mentioned that a group of interrelated projects which are executing together to achieve certain goal is called program while grouped projects, programs along with sub- portfolios operating for the same enterprise in order to accomplish agreed strategic purposes defines the portfolio (PMI, 2013). Projects can be executed in many fields such as construction, infrastructure, IT, etc... ; However, in this study our main focus is the infrastructure projects in UAE.

1.2.2 Infrastructure Projects

1.2.2.1 What is Infrastructure Projects?

Infrastructure projects is defined as projects that are established through the governments or other supporters in the aim to support as well as provide services to the local population such as land transport systems and building of transportation networks, public buildings, water supply and sewerage utilities, electricity transmission and distribution networks, energy networks, in addition to new enhancements to existing infrastructure related projects (EC, 2015; EAD, 2011).

It is substantial to introduce construction project at the aim of clearing up the difference between Infrastructure projects and construction projects as construction projects involves construction of new environments such as housing developments, hotel development, convention centers, airports or any enhancement to existing construction project (EAD, 2011).

1.2.2.2 The life Cycle of infrastructure Projects

European Commission Government provided a user guide that illustrated a model of the life cycle of an infrastructure projects that applied in such projects like the enhancement of land transport systems, and development of electricity, energy and water networks (EC, 2015). The main purpose of infrastructure projects is to develop economically useful enhancement with predetermined goals with regards to its specific timeline, estimated budgets and operative performance (EC, 2015). Infrastructure projects involve a complicated and resource-concentrated procedure; yet, a common life-cycle model for infrastructure projects that encompasses a series of stages made it easy to analyse all infrastructure projects (EC, 2015). These stages are demonstrated below in below with brief elaborations of each stage:

1) Project Specification and Feasibility

It is the early phase of the lifespan of an infrastructure project which involves defining the requirements and the way in which these requirements will be achieved such as determining the scope along with the needed quality of facility (Khang, Moe, 2008; Liu et al, 2015; EC, 2015; EIB, 2012). Furthermore, cost and benefit analysis is done to analyse the cost and the economical and operational benefits. Initial cost assessments might be presented at this phase (Khang, Moe, 2008; Liu et al, 2015; EC, 2015; EIB, 2012).

2) Outline Design

The second stage is outlining the plan of the work that will be undertaken in the project in which the general parameters of the scheme design will be established and which incorporate all the project's main components (EC, 2015; EIB, 2012). The main benefit of this stage is that it provides a foundation for a comprehensive design plan in addition to cost approximations of the design scheme; in addition to that it provides the essential information for the planning process (EC, 2015). Normally, this stage is known as the concept design stage.

3) Project Financing

Financing the project includes the preparation of the funds needed to cover the development, implementation as well as the post implementation maintenance of a defined project (EC, 2015).

The budget that will be prepared should include the followings (EC, 2015):

- 1- Budget allocated for development which covers feasibility and initial design stages.
- 2- Budget allocated for construction which covers the capital expenditure.
- 3- Budget allocated for contingency to cover any expected or non-expected cost overruns as well as delays.

The nature of the projects influences the structure and the form of project finance and the structure and timing of the project finance could enforce some constraints on the project design and project schedule (EC, 2015). Most of the infrastructure projects are being funded from local government sources while some projects might involve contribution from private sector in which they aim to own share and control over some or all the assets (EC, 2015).

4) Consents and Site Acquisition

The essential consents and authorisations should be ready and prepared ahead of the start of construction work, yet it should be considered that the time required to attain these is unpredictable and sometimes they include a significant influence on both timescale and costs for large infrastructure projects (EC, 2015). Besides obtaining the official agreement, consents might likely need to get achieved for water, electricity, gas, sewerage, health and safety, removal wastes, fire warranty, as well as highways privileges (EC, 2015).

5) Detailed Design

This stage is performed as a consequence stage to the outline design to determine the quantities of the needed materials and the work required in order to construct the project. Thus, drawings

and list of material quantities can be used to create a detailed project costs and schedule (EC, 2015).

6) Procurement of Contractors

The procurement of projects comprises the determination of the contractor who will be assigned to perform the related project work (PMI, 2013; EC, 2015). The straight approach to procurement pursued by most public sectors implicates requesting bidders to provide their tender that accommodate the advertised work and these requests could be limited to a list of preferred bidders or open to all firms (PMI, 2013; EC, 2015). Accordingly, the bidder will provide a tender which describe the followings (EC, 2015):

- The capabilities and experience of the bidder and its team in performing this certain project work
- The bidder proposed approach to the construction work
- The estimated cost to perform such work

7) Construction

This particular phase include the real project's work which mostly is done by the contractor based on a legal contractual agreement (EC, 2015). In order to agree on a contract, a decision must be made on the payment method by which the contractor will be paid which might be affected by a couple of factors which include (EC, 2015):

- The availability of the design documents which contract documents are proposed.
- Government regulations of the public sector subsidy parties.
- Project nature, project size, and the economic context.
- Time availability to implement the project work.

There are several payment types for contracts that clients would choose according to project's nature and the organization's financial terms and conditions. In each type of contract, the contractor would provide an estimate of the cost based on the scope of work. A clear agreement on the accountabilities of both project's sponsors and contractors must be available if any cost overrun occurred on the contract due to the associated project risks (EC, 2015). The construction works is measured as well to define the tasks to be accomplished or quantities of the material (EC, 2015). The contract price is generated once the works price is measured and their sums added to an element for profit as well as overheads (ibid). This method is considered much flexible since it allow changes and transact with it effectively, when the quantities of material estimation and contract price is accurately realistic, this will indicate that the project detailed design to be done before starting the construction works (ibid).

8) Project Handover

The date in which the contractor handover the work of the project to the sponsor should be defined in the contract since this date might diverge from the agreed one for many reasons; thus, many contracts incorporates the financial penalties for violating the handover date or rewards for achieving early completion (EC, 2015). Generally, the contract contains a retention clause which would determine a project total cost which will only be released to the contractor when the project sponsor is fully satisfied of the final project handover (EC, 2015; PMI, 2013).

1.3 Public sector projects

1.3.1 What is the public sector?

The public sector organizational structure has been conceptualised as a pyramids structure by many scholars (Sotirakou and Zeppou, 2005). In this pyramids structure, the policies, regulations

and choices are generated in the highest level, while the accountabilities are determined at the higher level, yet assigned to be fulfilled by lower levels throughout a defined hierarchical chain (Sotirakou and Zeppou, 2005). The highest level is where the power rests (Sotirakou and Zeppou, 2005). Boyne discussed the differences amongst public and private sectors due to some variables that affect the way in which the fundamental roles of the management are performed in both private and public sectors such variables as the composite organisational environment, goals, structure as well as managerial values (2002). Below illustrated table shows the significant dissimilarities amongst the public and private sectors organisations (Table 1).

The Public Sector Enterprises	The Private Sector Enterprises
Ownership: Jointly maintained by the political groups participants (Rainey et al., 1976).	Possessed by either entrepreneurs or stakeholders (Rainey et al., 1976).
Funds: Funded mainly by taxes received from public (Walmsley and Zald, 1973).	Funded by the payments received from customers (Walmsley and Zald, 1973).
Control: Controlled primarily by political powers (Dahl and Lindblom, 1953).	Controlled primarily by the market powers (Dahl and Lindblom, 1953).
Complexity: Results from varieties of stakeholders (Metcalf, 1993).	Limited stakeholders in private sector organisation in comparison with the public sector organisation (Metcalf, 1993).
Permeability: They are exposed systems which might be easily affected by exterior events (Ring and Perry, 1985).	The external parties' claims could be overlooked to the strategic formulation and execution (Ring and Perry, 1985).
Instability: More influenced by the political uncertainty (Bozeman, 1987).	Less influenced by the political uncertainty compared to public sector (Bozeman, 1987).
Competition: Involves less competitive stress (Boyne, 2002).	Involves more competitive stress (Boyne, 2002).
Goals: Targets several goals forced upon them by the many stakeholders that need to be satisfied (Flynn, 1997).	Goals are more focused in private sector organisation (Flynn, 1997).

Structure: Involves formal procedures In making decisions, less flexible and more risk (Bozeman and Kingsley, 1998).	More flexible in making decision and less risky compared to public sector (Bozeman and Kingsley, 1998).
Autonomy: Managers own less freedom to act in response to different situations (Allison, 1979).	Managers have more freedom compared to public sector (Allison, 1979).
Managerial Values: Less money-oriented (Pratchett and Wingfield, 1996).	More money-oriented (Pratchett and Wingfield, 1996).
Commitment: Mainly concerned with serving the public (Perry and Porter, 1982).	Majorly involved with the requirements of their clients (Perry and Porter, 1982)

Table 1: Differences amongst Public and Private Sector Organisations

Most of public sector enterprises are observed to be bureaucratic and divided based on functions (Spittler and McCracken, 1996). There have been addressed several reasons for the functions based division of the public sector organisations such as maintaining the chain of commands, isolating the steps in procurement, clearing out the responsibilities and making responsibilities easy to be traced (Spittler and McCracken, 1996).

1.3.2 Managing public sector projects

Spittler and McCracken discussed that since the time when humans started to build project for the public, the searches about how to manage these projects has continued (1996). Bakhsi added that ‘public sector project management’ has grasped great consideration in the literatures; yet, most of the published researches concentrated on specifically the public sector of the North American countries, Europe, Australia as well as New Zealand (1991). Public sector has been always observed to be more traditional with bureaucratic culture and deliberate response which in fact had a negative impact in managing the public sector projects (Spittler and McCracken, 1996). Furthermore, it has been recognised that a main aim in managing such public sector

projects is to confirm that the resources of the organisation are being consumed in accordance to the organisation's various goals and objectives; and to achieve this with a least budget, a convenient exercise for the right exact occupation must be always selected (Avots, 2000; Spittler and McCracken, 1996).

1.3.3 Infrastructure Projects in UAE

The infrastructure development projects in UAE are crucial substantial indication of development as it establishes heaps of investment opportunities across various related sectors. In 1971; when the UAE federation was set up, the population was mainly rural and the infrastructure was minimal, thus, the main aim of the new government was to offer the population with the best facilities which match with twentieth-century level of living (UAE Yearbook, 2008). Accordingly, Housing, roads, airports, ports, schools as well as hospitals were constructed and power, water along with telecommunications were provided by the careful usage of oil treasure and as a result, in the twenty-first century, all the facilities were well constructed and most of the population was urbanised (UAE Yearbook, 2008).

As a part of the booming UAE economy, government is continuously fueling infrastructure development projects on an exceptional highly scale. In the last 10 years, UAE has been invested more than US\$ 200 billion in infrastructure projects which include housing, roads and tourism, industrial along with commercial facilities, healthcare and education services, transportation, communications, utilities, ports as well as airports and which have been all undergone substantial redevelopments or remodeling (UAE Yearbook, 2007). This redevelopment or remodeling is characterised by a public-private partnership that took over these entire infrastructure projects along with both small and medium contractors, who actually work on a subcontracting basis and

operate the work (UAE Yearbook, 2007). Currently and as a part of the investment programme, the Ministry of Infrastructure Development is managing 12 dynamic infrastructure projects which are scattered around the UAE's emirates with a total cost of US\$ 389 million (El Heloueh, 2017).

1.4 Cost Overruns

1.4.1 Cost overrun in projects

Cost is a success indicator for projects while cost overrun is a major concern and a common phenomenon in projects worldwide (Azhar et al., 2008; Sweis et al., 2013; Murray and Seif, 2013;). There are lots of definitions proposed and illustrated in the researches for the cost overrun. Scholars have defined cost overruns as the phenomenon in which the cost exceeds the cost estimates or original cost and the more money is required to complete the project that had gone over the budget (Abdul-Rahman et al, 2008; Shete, Kothawade, 2016; Danso and Antwi, 2012; Kaliba et al., 2009; Memon et al., 2012). Danso and Antwi (2012) in addition to Park and Papadopoulou identified cost overrun as the differentiation amongst the real cost at the end of accomplishment and the planned estimated cost in the project's agreement (2012). Similarly, Love et al has linked the cost overrun to budget or cost increase and cost growth (2013). Azhar and Farouqi mentioned that a cost overrun is a chronic problem that occurs if the final cost goes beyond the original estimates (2008). Ali and Kamaruzzaman added that cost overrun is a universal phenomenon, cost overrun happens when budget exceeds budgetary estimate, when budgetary estimate exceeds estimation, and when settlement exceeds budget (2010).

1.4.2 Cost overrun in infrastructure projects

In any infrastructure project, the successful completion of the project with accordance to the planned budget is a major objective. However, the issue of cost overrun is strongly linked to most of the infrastructure projects and thus is considered one of the consistent features of infrastructure projects (Le Hoai *et al.*, 2008). Additionally, it is considered a universal phenomenon in infrastructure projects as it has been reported from numerous countries worldwide (Ali and Kamaruzzaman, 2010). Cost overrun would lead to a crisis in developing countries specifically when the actual cost exceed 100% of the project planned cost (Abd El-Razek *et al.*, 2008; Ali and Kamaruzzaman, 2010; Kaming *et al.*, 1997). According to a global study conducted on infrastructure projects which estimated that nine of ten projects have an overrun costs problem varying between 50 to 100 percent, hence; it was agreed that the issue of cost overrun issues specifically in the construction industry (Flyvbjerg *et al.*, 2003). Cantarelli has investigated on eighty seven construction projects in which it was concluded that the cost overrun has an average of 10.3 percent of existence in projects (2009). The emergence of costs overrun problems is also exists in the developed countries. For instance, in the United Kingdom (UK), approximately one third of all customers have remonstrated about their projects costs being beyond the expected budget, while 46.8 and 37.2 percentages of public and private sector projects respectively in Malaysia are exceeding the planned budget (Rahman *et al.*, 2013). One of the most popular infrastructure projects that were considered a failure because of the cost overrun is the Channel Tunnel project amongst France and the United Kingdom, the cost increased from its original cost which was £2600 million to £4650 million at the end of the project (Flyvbjerg *et al.*, 2003). Other more examples of cost overrun in infrastructure projects were depicted in several countries around the globe such as: the project of the Great Belt link in Denmark with a 54% cost overrun, the project of Humber Bridge in the UK with a 175% cost overrun, as well as the

project of the Paris Nord TGV in France that reported a 25% cost overrun (Flyvbjerg et, 2003). A study conducted in Korea revealed that 7 megaprojects; defined as projects with original cost above \$1 billion, had a 122.4% cost overrun at the completion and another 29 medium-sized projects; defined as project with original cost between \$50 million and \$1 billion, had a 32.5% cost overrun from its original cost (Heon, 2009). Another study incorporated 52 Megaprojects from various regions worldwide and their original cost between \$0.5 and \$30 billion (in 1984 value US dollars); however, the study illustrated that out of these 52 megaprojects only 4 projects met their cost goals, and the rest accumulated average of 88% cost overruns (Morrow et al , 1988). USA studies of cost management in 8 rail projects showed an average cost overrun of 61% (Pickrell, 1990; 1992). Furthermore, a Dutch study over 78 infrastructure projects included 37 in road, 26 in rail, 8 in tunnel and 7 in bridge showed that all of the above mentioned projects experienced 16.5% cost overrun compared to their original cost (Cantarelli et al, 2012). Moura et al mentioned that cost overrun is a key problem in infrastructure project of Portugal where large number of projects experienced an average of 12% cost overrun from the contracted cost (2007). Cost overrun was observed to be 14% of the contracted cost in Nigeria (Omorieg and Radford, 2006). Many studies have been conducted in Malaysia in order to analyse the performance and factors of cost overrun in infrastructure projects. In 2005, studies showed that 17.3% of 417 of the Malaysian government infrastructure projects were conceived unhealthy and out of control (Sambasivan and Soon, 2007). In addition to that, further study done in Klang Valley illustrated that a high percentage of their infrastructure projects were experiencing cost overrun issue (Ali and Kamaruzzaman, 2010).

1.5 Stakeholder Perspectives

As per the PMBOK stakeholders are the people groups, or organisations that affect or could be affected by the project or who have interest on the project (PMI, 2013). As a result of the different roles of the stakeholders in the project, their objectives as well as interest will differ. The study will mainly focus on the three stakeholders (clients, contractors and consultants) who are considered the key players in infrastructure projects as they will always impact or be impacted the most from the project cost overruns. The three key stakeholders are as the following:

1) **Client:**

Client is the main entity of the project's stakeholders for whom the project is constructed or carried out and this definition embraces both 'Commercial' Clients along with the 'Domestic' Clients (Cherns and Bryant, 2006). However, in few cases the client might not be clear, yet this ambiguity about who the client(s) should be resolved primarily by considering who (Thompson, 1991; Cherns and Bryant, 2006):

- Decides; at the end, what is to be done in terms of construction or etc., where, when and by whom.
- Initiates the idea and triggers the work;
- Heads the procurement chain
- Hires consultants who will perform the design and hires contractors who will perform the work
- Gives commissions to the contractor and consultant on the design and work constructed

2) **Consultant:**

On the other hand, consultant is defined as the individual or organisation that creates and amends the designs needed for the work that need to be implemented (example: construction work for the construction projects) and might include people such as: architects, structural engineers, quantity surveyors, building surveyors, mechanical and electrical engineers, as well as manufacturers (Sarda1 and Dewalkar, 2016). The consultant or designer roles include the followings (Sarda1 and Dewalkar, 2016):

- The arrangement of the design drawings
- Designing details of the work
- Detailing the specifications of the required work
- Producing bills of quantities and materials
- Agreeing (or ruling out) articles as well as substances
- Studying, computing the work.
- In many cases, consultants supervise the work performed by the contractor

3) **Contractor:**

Contractor is defined in literature as any party who directly engages workers to implement construction works or manages construction works. Contractors may include to their delivery organisation sub-contractors, that can be an individual, single trader, self-employed worker, or company to perform the construction work as well as manages or controls the work involved in the construction (William and Pyznar, 2003). The contractor experience, knowledge and skill are the key to their success in performing project work (William and Pyznar, 2003).

Infrastructure projects undergoing cost overrun would have the potential to turn into defaulted projects, and it would result on a substantial impact on the above three main stakeholders, for example if the funds dries up (Aljohani et al, 2017):

Clients: might not have additional fund to cover the overrun in cost, thus might not benefit from the service or facility if the projects have been delayed

Consultant: might suffer a significant increase in consultation and designing cost if rectifications are needed.

Contractors: might leave the site so as to work on other projects that have the needed funds and sometimes might lose their reputation and as a result will be stuck in one project only for long time.

1.6 Problem Statement

The growing complexity of infrastructure projects in UAE in addition to the environment in which the projects are taking place are setting more demands on the project managers to accomplish projects with the required quality according to the planned timeline and budget. Achieving successful implementation of infrastructure projects and maintaining control on the cost to be within the estimate is always challenging. However, till date several infrastructure projects in UAE are far exceeding the cost estimates such as the highway project Shahama-Saadiyat road which started in 2007 and was targeted for May-June 2009 with AED 5.43 billion as a total estimated cost. However, the project experienced overrun in cost and time that far exceed the estimates and expectations and finally was delivered on 5th Dec of 2012 with a cost overrun which was not published (Kumar, 2008). Another example is Dubai Metro project that experienced a cost overrun up to AED 12.5 billion as per confirmed by the government and which ended the project with a total cost of AED 28 billion because of the amendments that take

place within the project's scope and design from its original plans and estimates (Baldwin, 2009). It is observed that cost overrun is a major problem that is being experienced in infrastructure projects in UAE. What makes it a major problem is that most of the projects are big and the amounts of money that are invested in the infrastructure projects by the government are huge already. Thus, more concentration is needed to recognize the root causes behind it so as to better plan, manage as well as control it in an efficient way to avoid its consequential impacts. In this regards, this research study will therefore shed some light on the focal factors causing the issue of cost overrun in public sector infrastructure projects in UAE. The main causes will be identified from the perspectives of three key stakeholders clients, contractor, and consultant. Thus, the research demands answers to below questions:

Research Questions:

1. What are the causes of costs overruns on projects?
2. What are the most significant causes of cost overruns in most infrastructure project in UAE? (From stakeholders' perspective).

1.7 Aims and Objectives of the Research Study

This dissertation aims to explore the causes of cost overrun in public sector infrastructure projects in the United Arab Emirates (UAE), in which a stakeholder driven perspective of cost overruns is developed. The subsequent are the major objectives of this research study:

- To investigate the main factors of cost overruns through a inclusive literature review
- Examine how the factors of cost overruns in infrastructure project is conceptualized by three main stakeholders (clients, contractors, and consultants) via a questionnaire that intends to gather data with accordance to their real expertise and practices pertaining to the management of infrastructure projects in the United Arab Emirates (UAE)

- Propose some recommendations to minimize the cost overruns associated with public sector infrastructure projects

2.0 Chapter 2: Literature Review

2.1 Cost overrun

Project cost is a key concern in the whole project throughout its lifecycle and can be conceived as a major factor of a project success and the motivating force of project accomplishment (Allahaim and Liu, 2012). Even though cost has been proven for its significance in the project, it is still observed that many infrastructure projects are still failing to realise its objectives within the planned estimated cost (Allahaim and Liu, 2012). Cost overrun is observed differently from project to project; however, it is popular for infrastructure project and has been considered as one of its features (Azhar et al., 2008).

2.2 Causes of Cost Overrun

Understanding the factors of cost overruns is crucial for a successful infrastructure projects. This section will present the causes of cost overrun for infrastructure projects as been demonstrated by previous studies.

2.2.1 Inadequate Project Management

Both project managers and project management team play a crucial role in containing the project's costs. Having a poor project managed by a good project manager often lead to pleasingly project completion; nevertheless, a good project if joined with inadequate project management would mostly lead to have serious complications (EC, 2015). An inadequate project management structure will negatively influence all phases of the project's construction process resulting in an insufficient planning and coordination along with weakening the communication amongst the project team members and project sponsors (EC, 2015). Furthermore, poor project

management generates failures to problems identification as well as the institution of the required design and programming amendments. Mansfield et al. from their investigation on the causes of the considerable cost variations from the initial contracted cost along with the cost overrun, emphasised that poor project management will lead to not only lacks in the projects' plan as well as cost control, but also will lead to risk the target results anticipated by clients, contractors, and consultants in the whole implementation process (1994). Besides, deficient manipulation over time and cost inputs is a result of poor project management (EC, 2015). This result is similar to the output of studies in developing economics who concluded that lack of knowledge in project management techniques and best practices contribute to cost overrun in projects (Aje et al, 2009; Hassanien and Afify, 2007). Sripraset also added that the inefficient construction management system as well as ineffective designed control system used during an infrastructure project's period would result to cost overruns problems (2000). Iyer and Jha explained although the technical capabilities of the project team is a vital factor to the success of the project, the input from contractors and consultants in the course of cost estimation, monitoring and controlling is just as essential in attaining overall success in projects (2005).

2.2.2 Funding Problems

A number of significant financing problems may develop during the project period such as having shortages of the required budgets to complete a project or payment suspensions of project services by the project sponsors (EC, 2015). In cases where substantial increase of project costs beyond the originally estimated budget happens, the project may have to get suspended or postponed until additional capital is obtained (EC, 2015). Financing problems may exist when the allocated capitals of a project have been distracted to some other projects under the same programme of development (ibid). Consequently, in cases where the project invoices are paid

slowly by project sponsor; fewer resources may be dedicated by the contractor or may also stop the work if cash flow develops an issue (ibid). While in other scenarios mainly in revenue-generating projects where projects are anticipated to be totally profitable, the obtainability of local funding is minimized by the sponsor of the project so as to make the most of the grant level (ibid). Accordingly, it might cause subsequent problems to the contractors by decreasing the availability of anticipated financing which might have been planned for other projects (ibid).

2.2.3 Improper Cost Estimation

Cost estimation exercise is one of the typically complicated and crucial exercises that take place in a project's lifecycle and used as a base for the cost management plan (PMI, 2013). Even though the estimation methods are being improved through years; nevertheless, they are still highlighted as imperfect (Aljohani et al , 2017). There are several factors that cause cost underestimation and some of these factors are likely cause of cost overruns. Psychology is one of the aforesaid factors through which psychologists agree on the fact that the majority of people lean towards being optimistic more than being realistic which is defined as optimism bias (Lovallo and Kahneman, 2003; Kahneman and Tversky, 1979). In this scenario, project's cost estimators and contractors take decisions on a delusional optimism basis, greater than real rewards and lower than real risks, and not based on a rational measurement of both gains and losses (Lovallo and Kahneman, 2003; Kahneman and Tversky, 1979). The defective data utilised in bid estimations, unreliable database for costs, lack of cost estimators' expertise and honest mistakes are some other factors to cause failures in project's cost estimation (Aljohani et al , 2017). Likewise, and on the other hand, project estimation that ends up being less than the actual value of the anticipated values of the project would also lead to consequent budget overruns (EC, 2015).

2.2.4 Payment Delay

The underachievement to release timely payments to project's contractors for the accomplished work makes it very challenging for contractors to meet the expected project's objectives (Assaf et al , 2001). The delay in work payment exhausts both time and money of the contractor as well as it can impact the trust relationship amongst client and contractors (Agyakwa-Baah, 2009). Furthermore, when the payments are delayed by the client then it could generate an overrun of the project's costs since the related project's contractors will maximise their overhead costs at the aim of covering the accumulated risks by delays (Denini, 2009).

2.2.5 Poor Tendering Documents

Undeveloped documentations of tendering were highlighted as a critical cause of cost overrun. Numerous factors do lead to poor tendering documents such as engaging the project's designer as a consultant which would add a level of communication gaps amongst project's designer and contractor (Aljohani et al, 2017). Besides, lack of detailed work drawings and specifications and insufficient coordination among the related project parties are other factors. Also, having a shortage of human resources during the design firm with the needed skills can cause the tendering document to end up being misleading (Aljohani et al , 2017). Consequent to the above causes, a poor tendering document would lead to manipulating the project parties towards the project main objectives. Thus, the project would require further financing to be completed as anticipated (EC, 2015).

2.2.6 Inappropriate Contractors Selection

During the project lifecycle, contractors are chosen prior to executing the project. The selection process is mainly made based on the price as well as the contractors' expertise in producing a quality work that meets the set time, budget and cost in particular types of projects (EC, 2015).

In the scenario where the high level of development is carried out in a specific area and the good contractors don't offer the work; problems may take place (EC, 2015). On the other hand, there might not be experienced personnel on the requested service to perform the tender review process (ibid). Accordingly, the selection will not be appropriate and the selected bidder would not be qualified to do the work required since the selection is done based on cost not quality of work (ibid).

The emergence of suspensions in the implementation of a project combined with costs increases may happen due to utilizing ineffective labors or having errors in the calculations of their anticipated productivity (ibid). This may occur especially when the quality of the employed sub-connectors is not controlled in the core contract of project (ibid). A number of delays cases during the construction period take place due to the liquidation of contractors and sub-contractors which may also lead to raise costs as a result of the retendered remaining work by the project sponsor (ibid). Additionally, having a just new to the job contractor to take over other contractor's job is challenging due to the feasible obligations which the new to the job contractor will undertake for another company's work (ibid).

2.2.7 Lack of Contractors Experience

Currently, construction projects are becoming more complex which result in adding pressures on the expected time of project completion and thus the required contractor's expertise (Arain et al, 2006; Clough, 1994). In case where the contractor is lacking the experience of the type and location of the project, then the work will require re-build and accordingly delayed which raises the cost of implementing a project (Arain et al, 2006; Clough, 1994). According to Arain et al and Clough, the lack of required expertise in a construction project is agreed to be a critical factor impacting the performance of projects (2006; 1994). In light of this, it was found that lack

of contractor's expertise was one of the focal factors leading to the issue of cost overruns in various developed countries (Arain et al, 2006; Clough, 1994).

2.2.8 Contractors Financing

The financial status of project contractors plays a crucial role in accomplishing a project just on time (Aljohani et al , 2017). A number of challenges are confronted by contractors during the construction stage of a project, since the payment of project's works and receipt of payment are normally done after accomplishing either a part of the project or, in many scenarios, the entire project (Aljohani et al , 2017). For this reason, contractors must assure their funds to be sufficiently available to allow them undertake projects (ibid). Also, implementing up to date efficient project financing practices help contractors in controlling the financing processes that take place during project's lifetime (ibid). In some cases during the construction phase where an ineffective control of both project's costs and cash flows occurs, immediately the project costs rise and this could end up with financial penalties because of the acquired project suspensions (ibid). So, if the contractors face financial challenges that cannot be resolved effectively, the project's progress will be negatively influenced (ibid). It was found that a project contractor facing financial issues is basically a main cause of project failure in multiple contexts and it was ranked as one of the most five causes leading to project underachievement in some of the developing countries (ibid), and thus, would lead to the need for further budget needs to finalise the project scope.

2.2.9 Frequent Design Changes during the Construction Phase

Even though having an infrastructure project delivered with no discrepancies throughout the construction phase is quiet uncommon, yet processing the design change orders slowly can undesirably influences both the originally estimated timescale and cost of the project (Alsuliman

et al , 2012). A project's design modifications result from many causes. It might be to add more components to the project or changes to the current ones requested by project sponsor (EC, 2015). A change in the design of a project might be part of an infrastructure project nature due to its difficulty and ambiguity (Aljohani et al, 2017). Normally these design modifications necessitate additional time inputs from both the client and consultants, besides the extra time and cost inputs required from related contractors for the additional needed materials (EC, 2015). Also, the existence of design change in project lead to delays in a project period since it needs to be reviewed and endorsed by project's related clients (Aljohani et al , 2017). Nevertheless, the aforementioned cause was found to generate cost overruns in various developing countries besides the developed countries (Aljohani et al , 2017). It was also found that the design change in a project was the highest ranked factor to cause cost overruns in the developing countries (Oladapo, 2007; Arain and Pheng, 2005). The nuclear definition of project's scope and objectives was primarily the cause of numerous design change orders in construction projects in both developing and developed countries (Aljohani et al , 2017).

2.2.10 Poor Material Management

The construction material is a significant basic in the implementation phase of any construction related project (Aljohani et al, 2017). The significance of material management can be clearly realised from its definition as per stated by Patel and Vyas, in which it was defined as (2011, p1):

“The system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost and most importantly are available at the point of use when required”.

The ineffective material management could substantially lead to late distribution of materials as well developing risks of purchasing at greater costs, hence resulting in project's delays and cost overruns (Patel and Vyas, 2011). As the number of construction projects is constantly increasing, it is becoming challenging for the manufacturers to meet the high level of demand for specialised building materials (Patel and Vyas, 2011). In light of that, project's contractor could be challenged by the lack of construction materials in the market or the increases of materials prices which ends up in project's cost overruns (Aljohani et al, 2017). The fluctuated prices of materials as well as the poor material management have been emphasised to be a key factor that cause project cost overruns in fifteen out of seventeen conducted studies (Aljohani et al, 2017). It was found that Nigeria, Indonesia, Vietnam, Ghana and Saudi Arabia are suffering from projects overruns due to the aforementioned cause. Some other causes that result in managing materials ineffectively are (Aljohani et al, 2017):

- Unreliable material providers;
- Lack of materials and funds required for material procurement;
- Unreliable statistics on material availability;
- Variations in the obtainability of construction materials;
- Uncertain deliveries of required materials

3.0 Chapter 3: Conceptual Framework

The topic of cost overruns of projects over years has been studied extensively by researchers. Depending on the era of the study or the interest of the researchers, the topic has been covered from different perspectives. In the early studies of project cost overrun topic, studies were mainly focusing on the successful of the development projects within the limited available budgets. While recently, researchers have been focusing on specific reasons aiming to resolve an issue in a certain project, or achieving some targeted business goals. Some researchers have focused on the categorisation of the cost overrun causes, internally and externally. While others have tried to examine the different causes and rectification approaches of cost overrun in different cultures or geographic areas. For example, Aljohani in his latest researches on project cost overrun provided a summary of previous studies conducted on various geographic areas on the factors of cost overrun (Aljohani et al, 2017).

In his summary, he mentioned that the overall number of factors identified through the 16 studies were 366 factors. However; after the identical factors were eliminated and the related factors were combined, the total number of causes ended up with a 175 factors for cost overrun (Aljohani et al, 2017). Causes were then classified as internal and external factors to the project and each class encompasses a number of sub-classes of factors: project financier, project client, project contractors along with projects consultants were sub-classifications of the internal factors, whereas system, country related, economic related as well as weather were sub-classifications of the external factors (Aljohani et al, 2017). The most common factors of cost overrun have been explored in the literature review.

At the time that cost overruns in projects has been widely studied over years. However, there are still gaps in the literature that focuses on the stakeholder perspective of the cost overruns in the public sector on UAE. Additionally, most researchers have approached and analysed the topic from a single entity's perspective. Nevertheless, none of the studies were established to cover the topic from the holistic viewpoint of stakeholders. Finally, infrastructure projects are mainly not the focus of researchers as the projects normally don't attract the attention of individuals and the media as the mega superstructure projects.

Hence, a full study is needed to focus and link all of the causes of project cost overruns combining the practices of the stakeholders in the project lifecycle. This research study intends to clear up the missing gaps of the proposed literature and aid the project managers via developing a comprehensive list of potential causes that shall be managed to avoid the consequences of cost overruns.

The findings of this study of will focus on the foremost shortcomings of clients' practices in the concerned authorities in this specific study. Additionally, the study will highlight further the reasons that lead to project cost overruns from the contractor and consultants processes.

These factors of cost overruns have been realised via defining most common causes of project cost overruns demonstrated in the previous researches and literature. After that, the causes were examined in the limitation of the study scope. All of this were done in the aim of identifying the most common factors of cost overrun in the infrastructure projects in UAE, which will need their consideration to overcome their consequences.

Accordingly, in this particular research study, the factors of infrastructure project cost overrun have been explored in literature review. These factors will be studied and analysed from the perspectives of three stakeholders (client, contractor, and consultant). The three stakeholders' poor practices would impose the studied list of cost overrun factors which at the end would lead to increase the project budget.

The following diagram (Figure 1) illustrates the main variables of this study. It shows the three key stakeholders who are considered the key players in infrastructure projects as they will always impact or be impacted the most from the project cost overruns. In addition to that, the main factors of infrastructure projects cost overrun that have been explored earlier in the literature review chapter are listed in the diagram and linked to the issue of project cost overrun.

Hence, in consistency with the aforementioned cited studies in the literature review along with the conceptual framework, the relation between the cost overrun factors and project cost overrun will be studied based on the perspectives of the three main stakeholders. The main hypothesis of this study is:

- Inadequate project management has a positive correlation with cost overrun.
- Funding problems has a positive correlation with cost overrun.
- Improper cost estimation has a positive correlation with cost overrun.
- Payment delay has a positive correlation with cost overrun.
- Poor tendering documents has a positive correlation with cost overrun.
- Inappropriate contractors' selection has a positive correlation with cost overrun.
- Lack of contractors experience has a positive correlation with cost overrun.
- Contractors financing has a positive correlation with cost overrun.

- Frequent design changes during the Construction Phase has a positive correlation with cost overrun.
- Poor material management has a positive correlation with cost overrun.

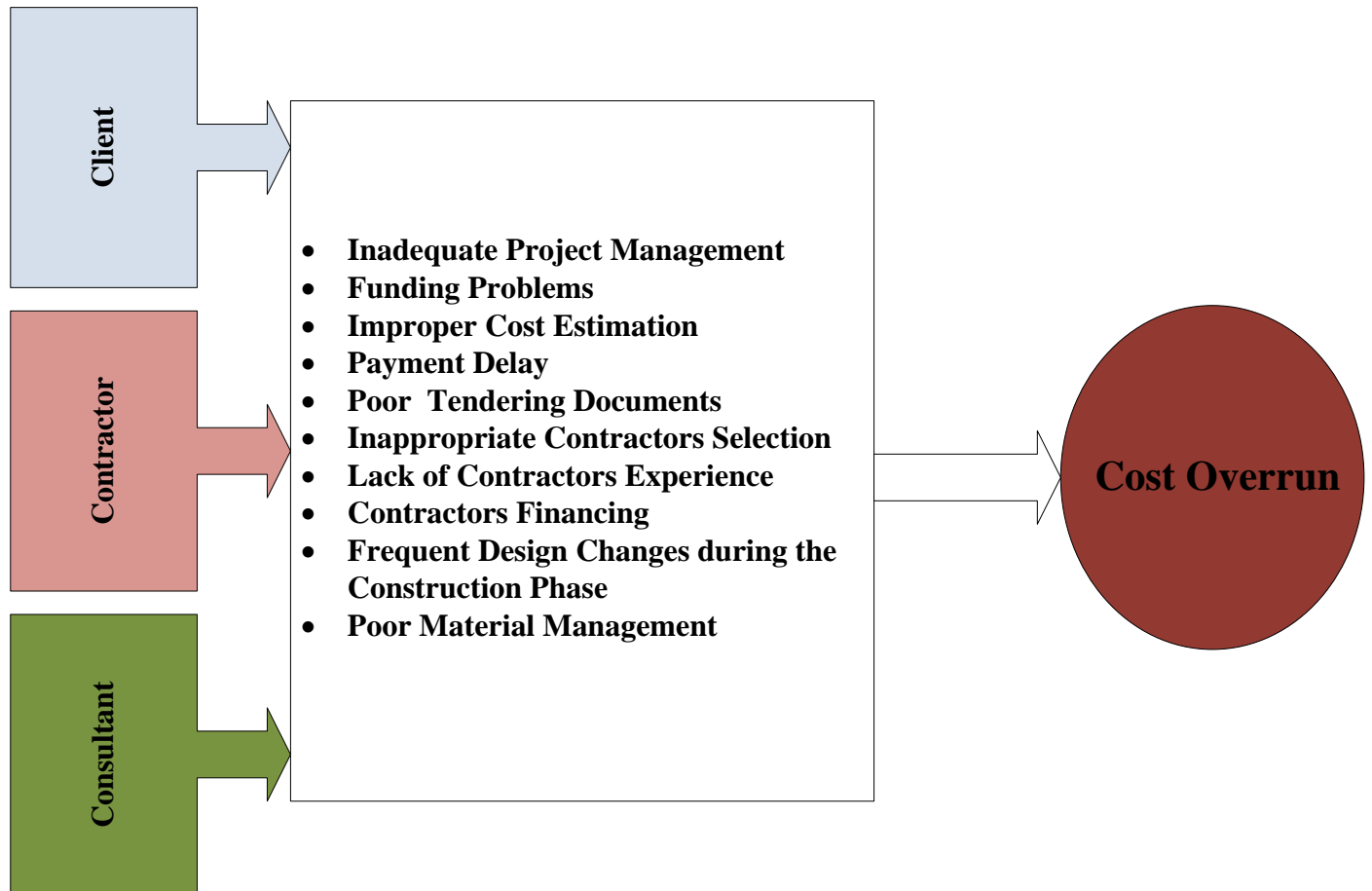


Figure 1: Main Variables of this study

4.0 Chapter 4: Research Methodology

Throughout this study, project cost overruns have been intensively studied by reviewing a number of present Literatures comprising journal articles, books and additional references. Subsequently, the specific perceptions of stakeholders which can disturb the budgets of projects have been presented. It must be mentioned that cost overruns were the main focus of this specific study. Firstly, an extensive research has carried out to highlight the conception of cost overruns, as illustrated in the third chapter of framework. Thereafter, the root causes of cost overrun and all its related motives that result in maximizing the defined project's cost have been highlighted, studied and demonstrated. An analysis and examination of the attained data from the literature have been undertaken within the scope of this research study.

In this specific study, quantitative approach has been implemented in order to examine the outputs of the literature review as well as gather data from real project cases. The quantitative method has been implemented to basically examine the factors of cost overruns along with the stated circumstances in the literature review. In this method, a circulation of surveys was carried out for the process of gather data from not only real project cases, but also from the recent practices associated with the present situation. Responses data have been later statistically investigated to examine the correlation amongst the dissimilar reasons and their influence on the costs of projects.

The main reason behind using the quantitative approach in this research study was to gather an exact data pertaining to the causes of project cost overruns for the particular covered infrastructure projects in the scope of this dissertation.

These causes have been possibly examined in an objective and impartial manner as to enable identifying the root causes with regards to the dissertation problem statements so that they can be statistically tested. The standardized questionnaire was the utilized technique for the undertaken quantitative approach throughout this research study. The received feedback data have subsequently been analyzed through the use of statistical approaches to examine the relationships amongst project cost overruns and their particular root causes. The selection of the research study participants has been carefully done as to cover the possible research study population of the investigated projects.

Accordingly, the SPSS statistical software was utilized to statistically examine the gathered data from the conducted questionnaires. An identification of the dependent and independent variables of the SPSS analysis was done. The cost overrun has been identified as the dependent variable, while the causes of cost overrun, which were defined earlier, were identified as the independent variables. The aforesaid examination consisted of three main tests those of reliability, correlation and regression tests which have been applied on the gathered data.

Starting by the reliability test, which was performed to evaluate the measures utilized in the research study as well to confirm whether they can represent reliably the variable of the study. Cronbach and Richard debated the reliability test and stated that the key output of it is mainly the Cronbach's alpha (α) which was utilized to evaluate the interior reliability score for a sample of the psychometric test (2004). A number of scholars stated that α should minimally be equal to 0.8 in order to surely consider that measure as instrument and must be set subsequently in most of the researches (Gliem and Gliem, 2003). In this specific study, the reliability test has been carried out on all the independent variables where the value of α was set to 0.8, according to the

previously proposed studies. For instance, the measures demonstrating the independent variable of 'inadequate project management' were examined in the reliability test in order to confirm these measures of reliability as well as consistency.

Therefore, the average of the independent variable measures of the 'inadequate project management' would be considered only as reliable to be utilized in this research study; if only the value of α given by the SPSS was greater than 0.8. Otherwise, a particular measure from the list of the examined measures could be deleted via the procedure of the 'if item deleted' in the SPSS. Applying the exact procedure, the reliability test must be undertaken in both independent and dependent variables measures of this research study. During the computation process of all the average values of the whole involved variables, the measures that were eliminated via the procedure of 'if item deleted' would be omitted.

On the second hand, the correlation test was carried out via the SPSS at the aim of testing the relationship amongst every independent variable with the dependent variable. The significance α is actually the major output of the correlation test carried out to test the relationship amongst every independent variable along with the dependent variable. According to the studies conducted by Thompson in which the correlation test was clarified, it was declared that the level of significance α is greatly utilized to discover the rejected region of the distributed sampling (2004). This will be utilized to test and determine whether the result which is gained from the sample shall be implemented to the entire population and the standardized values of the significance are 5%, 1% and 0.1% which is 0.05, 0.01, and 0.001 respectively as stated by Thompson (2004). In this particular study, the 0.05 is considered as our significance level which demonstrates that the confidence level is actually 95% according to the fact that a level of 5% is frequently decided to be conformist (Stigler, 2008). In addition to all of the above, the 'p value'

which is an output of correlation test indicates the accuracy of the correlation. If α is more than the 'p value', in this case the null hypothesis would be excluded and vice versa. For instance, if the p value amongst the variables of 'inadequate project management' and 'cost overrun' was below 0.05, then this indicates that there is a correlation amongst the aforementioned variables.

Finally, after the correlation among the dependent and independent variables was identified then the regression analysis was performed as to classify the relationship of the independent variables of this study (inadequate project management, funding problems, Improper cost estimation, payment delay, poor tendering documents, inappropriate contractors selection, lack of contractors experience, contractors financing, frequent design changes during the construction phase, and poor material management) with the cost overrun as the dependent variable of this particular research study.

The coefficient of correlation r^2 is the key output of the regression test which calculates the amount of the difference of the studied dependent variables with regards to the difference of the examined independent variables. For instance, if the r^2 was indicated to be 0.70 during the performance of the regression test on the cost overrun (dependent variable) and inadequate project management (independent variable), it would show that 70% of the difference of the cost overrun variable shall be clarified by the inconsistency of the inadequate project management variable. This indicates, on other words, that 70% of the cost overrun is influenced by the inadequate project management. In addition, the regression test also given the coefficient (β) for the linear relation amongst both independent and dependent variables as illustrated by the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon$$

Likewise, the ANOVA analysis is another major output of the regression test that determines other outputs of it in terms of their reliability, acceptability and the ability to be replicated over the entire population. It was applied on the chosen sample of stakeholders those of clients, contractors and consultants in the UAE from the entire UAE population. It is important to mention that if the significant value was below 0.05, then it would be indicated that it is safe to generalize the outputs in the entire population.

5.0 Chapter 5: Data Collection and Analysis

5.1 Introduction to Data Collection and Analysis

The quantitative research technique will be utilized in this chapter at the aim of assessing the literature review outputs with regards to the cost overrun causes in the public sector of the United Arab Emirates (UAE) infrastructure projects. Questionnaire has been developed online and will be undertaken as the quantitative research method, which will be utilized to collect data and responses pertaining to the different factors that cause costs to overrun which have been studied in literature review section from key stakeholders. The online questionnaire will be distributed via email and linkedIn application in order to get as much responses as possible. After that, the gathered aforesaid data and responses will be assessed statistically through the usage of a software namely SPSS which stands for Statistical Package of Social Science. The statistical output will help to determine subjective outcomes about the most mutual factors of cost overrun in public sector infrastructure projects in UAE from the perspectives of key project stakeholders (client/sponsor, consultant and contractor). Lastly, those outcomes will be used to generate recommendations to mitigate cost overrun phenomena particularly in public sector infrastructure projects in UAE.

5.2 Study Samples

In this research, the study sample targeted key stakeholders which include client/sponsor, contractor and consultant who have experience in the public sector infrastructure projects in UAE. The online questionnaire help in widening the population range to cover more than 20 leading companies in UAE who were involved in public sector infrastructure projects as a client or contractor or consultant. Accordingly, the data and feedback were collected from the

experienced employees who were involved in public sector infrastructure projects from more than 20 leading companies in UAE. The population of this study comprises key stakeholders in public sector infrastructure projects in UAE. The sample that has been selected to represent our population consists of 80 experienced employees from 20 different companies in UAE. The chosen sample for this particular research study is meant to be from numerous companies because the variability of sampling increases the confidence that the chosen sample do have the features of the remaining population. Companies' names were kept confidential in order to give trust to the respondents and allow them to provide honest answers for the questions.

5.3 Quantitative Research Approach

As stated in the previous section, quantitative research approach was used. It was essential to be adopted in this study, not only to collect dissimilar viewpoints of the key stakeholders within the scope of this research paper but also to gather data that statistically have an absolute correlation amongst the studied causes of cost overrun and the cost overrun itself.

Online questionnaire from survey monkey was developed and was distributed to employees via email and linkedIn to collect data and feedback about studied causes of cost overrun in public sector infrastructure project in UAE. It should be stated here that from the literature review, 10 main causes of cost overrun were identified. The 10 factors causing cost overrun can be taken into account as independent variables in the quantitative research method. Thus our major independent variables for this study are 'Inadequate Project Management', 'Payment Delay', 'Funding Problems', 'Improper Cost Estimation', 'Poor Tendering Documents', 'Inappropriate Contractors Selection', 'Lack of Contractors Experience', 'Contractors Financing', 'Frequent Design Changes during the Construction Phase', and 'Poor Material Management'. While, the main dependent variable is cost overrun.

The questionnaire was designed and developed online in a way that asks couple of questions that represent each measure of this study for the independent variables. Respondents of the questionnaire provide their feedback about each of these measures based on their experience on a project that they were involved in and had a cost overrun. Accordingly, their feedback was investigated statistically through the SPSS software to define the correlative relationship amongst the various variables of cost overrun causes and cost overrun.

Appendix 1, displays the questionnaire utilized in this research study that was designed and developed based on the information studied from the proposed literature review on the different causes of cost overrun in public sector infrastructure projects in the UAE. Questions (1) define the respondent organisation type (client, consultant, and contractor). Question (2-47) demonstrated the main factors for cost overrun. Questions (48-49) define the size of the project that the respondent experienced cost overrun while working on it and if there was a consultant involved in the project. Questions (50-53) represent the impact of the above mentioned cost overrun causes on the budget.

5.3.1 Data Presentation

Table 2 elaborates the distribution of study sample with regards to the organisation type (owner/client, consultant, and contractor). The online questionnaire link was distributed via email and linkedIn. The total numbers of respondents who successfully filled and send back their responses were 80.

	Organisation Type
Owner/client	30
Consultant	40
Contractor	10
Total	80

Table 2: Distribution of Study Sample

5.3.2 The Study Model and Variables

In this research study, the analysis incorporates 10 independent variables that represent the causes of cost overrun and 1 dependent variable that represent cost overrun. The statistical analysis was carried out at the aim of evaluating whether a correlation exists between the studied variables. The variables of this study were defined and represented via number of measures. The measures were evaluated by examining them in the reliability test through the usage of the SPSS in order to ensure that every single measure is acceptable to be a representative to its corresponding independent or dependent variables. Figure 2 illustrates the proposed study of the relationship between causes of cost overrun variables and cost overrun.

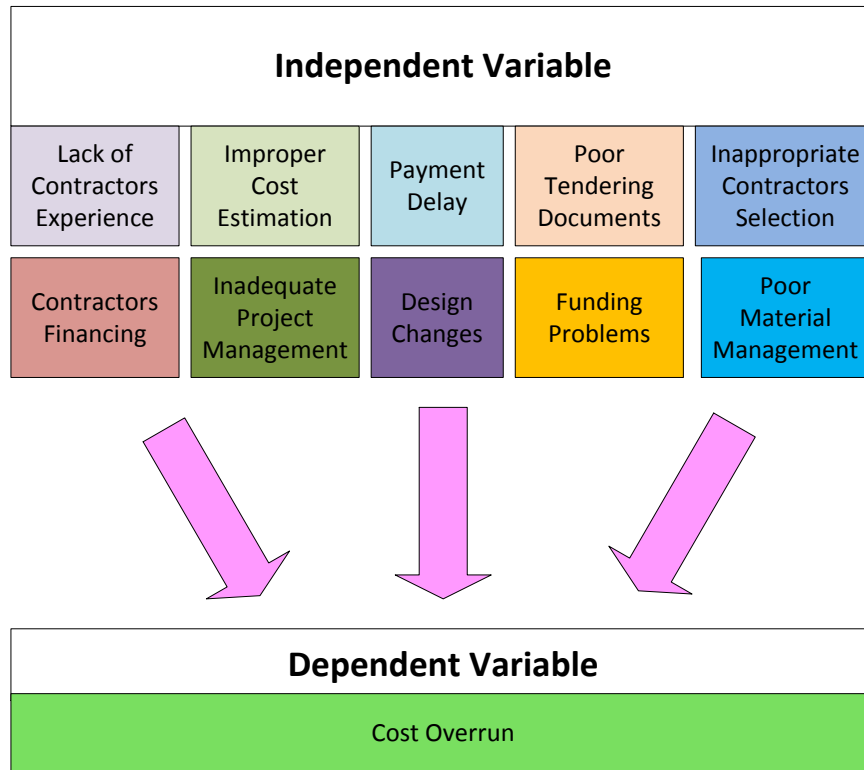


Figure 2: Dependent and Independent Variables

5.3.3 Variables of this Study

The following assumptions are considered in this study:

- The investigated causes of cost overrun do not correlate
- The means of cost overrun can be combined through a straight line for the whole values of the defined cost overruns' different causes.
- The below model of linear regression illustrates the linear relationship amongst the studied dependent variable, cost overrun, and k number of the independent variables, cost overrun's different causes

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon$$

In which:

- Xs: Independent variables
- Ys: Dependent variable;
- Bs: Regression coefficients
- ϵ as the error term.

5.3.4 Data Analysis

Throughout this section, the gathered data through the online questionnaires were statistically analysed in SPSS software. Three different tests of reliability, correlation and regression were implemented on the collected data and the following sections will present the findings of the three different tests.

5.3.4.1 Reliability Test

First, the reliability test was implemented on the gathered responses through SPSS in order to examine the utilized rules / scales to measure both dependent variable and independent variables of this study. The undertaken Cronbach's Alpha value was 0.8 and according to this, the reliability test was implemented in all independent and dependent variables to check the acceptance of the measures used to represent each of these variables. Table 3 is a detailed illustration that shows the attained results of the conducted reliability test via the SPSS software.

Variable	No. of Cases	No. of Items	Reliability
Inadequate Project Management	80	4	0.969
Funding Problem	80	4	0.970
Improper Cost Estimation	80	4	0.969
Payment Delay	80	4	0.970
Poor Tendering Documents	80	4	0.968
Inappropriate Contractors Selection	80	4	0.973

Lack of Contractors Experience	80	6	0.981
Contractors Financing	80	5	0.961
Frequent Design Changes during Construction Phase	80	5	0.976
Poor Material Management	80	6	0.980
Cost Overrun	80	3	0.951

Table 3: Reliability Results for Each Variable

First, the reliability analysis through SPSS software was applied to examine the 4 measures that represent inadequate project management. As illustrated in Table 3, the output shows that the Cronbach's Alpha value is 0.969 that is more than 0.8 as well as considered as an acceptable value. Hence, the average of the 4 measures of the inadequate project management can demonstrate the *inadequate project management*.

Second, the analysis was performed to check the 4 measures that represent funding problems. The Cronbach's Alpha value is 0.970. Hence, the average of the 4 measures for funding problems can demonstrate the *funding problems*.

Third, it was found that the Cronbach's Alpha value of the 4 identified measures of improper cost estimation is 0.969 that is considered as an acceptable value. Hence, the average of the 4 identified measures of the improper cost estimation can acceptably and successfully demonstrate the *improper cost estimation*.

Fourth, it was shown that the value of the Cronbach's Alpha for the 4 measures of payment delay is 0.970. Hence, the average of the 4 measures of payment delay can demonstrate *payment delay*.

Fifth, the Cronbach's Alpha for the 4 measures of poor tendering documents is equal to 0.968. Hence, the average of the 4 measures of poor tendering documents can acceptably and successfully demonstrate the *poor tendering documents*.

Sixth, the Cronbach's Alpha for the 4 identified measures of inappropriate contractors selection is equal to 0.973. Hence, the average of the 4 measures of inappropriate contractors selection can acceptably and successfully demonstrate the *inappropriate contractors selection*.

Seventh, the value of the Cronbach's Alpha for the 6 identified measures of lack of contractors experience is 0.981. Hence, the average of the 6 measures of lack of contractors experience can be acceptably and successfully demonstrate the *Lack of Contractors Experience*.

Eighth, the Cronbach's Alpha for the 5 measures of contractors financing is 0.961. Hence, the average of the 5 identified measures of contractors financing can acceptably and successfully demonstrate the *contractors financing*.

Ninth, the Cronbach's Alpha value for the 5 identified measures of frequent design changes during the construction phase is 0.976. Hence, the average of the 5 identified measures of frequent design changes during the construction phase can acceptably and successfully demonstrate the *frequent design changes during the construction phase*.

Tenth, the value of the Cronbach's Alpha for the 6 measures of poor material management is 0.980. Therefore, the average of the 6 identified measures for poor material management can be acceptably and successfully demonstrate the *poor material management*.

Finally, the Cronbach's Alpha value for the 3 identified measures represented project cost overrun is 0.951. Hence, the average of the 3 measures of project cost overrun can acceptably and successfully demonstrate the *cost overrun*.

Based on the conducted reliability test, the entire independent variables representing the causes of cost overrun as well the dependent variable of cost overrun is going to be demonstrated as an average value of its measures.

5.3.4.2 Correlation Test

The main aim of the correlation test is to investigate whether there is a correlation or not between the dependent variable “cost overrun” and the 10 independent variables that represent causes of cost overrun. As mentioned in methodology chapter, the p value which is the value of Pearson Correlation is the main output of correlation test by using the SPSS. P values determine where there a correlation exists between the studied dependent and independent variables. The following illustration of Table 3 represents the output acquired from the correlation test through the usage of the SPSS software between cost overrun and 10 independent variables. Table 4 shows detailed results of the correlation test which was achieved by utilizing the SPSS software.

Independent Variables	Pearson Correlation values with Cost Overrun
Inadequate project management	0.852**
Funding problem	0.825**
Improper cost estimation	0.838**
Payment delay	0.815**
Poor tendering document	0.842**
Inappropriate contractors selection	0.845**
Lack of contractors experience	0.842**
Contractors Financing	0.901**
Frequent design changes during construction phase	0.946**
Poor Material Management	0.986**
Average of all cost overrun causes studied	0.896**

Table 4: Correlation Matrix between all Variables (Pearson Correlation values)

** . Correlation is significant at the 0.01 level (2-tailed).

The investigation on correlation amongst this study’s dependent variable (cost overrun) and the 10 independent variables was attained by the usage of the Pearson correlation coefficient. As shown in the table 3, the relations amid the dependent variable “cost overrun” and every 10

independent variable that represent the causes of cost overrun is positive correlation with a strong significance level, $p < 0.01$. Accordingly, all the hypotheses of the study which centered on the positive correlation between the “cost overrun” and all the 10 studied causes of cost overrun are correct and accepted.

The average of all the cost overrun causes (independent variable) has been computed in order to check the relation between the average of all the causes and the cost overrun dependent variable. Accordingly, correlation strongly exists between the average of all the causes of cost overrun and the cost overrun as shown in Table 4. The output shows that there a positive correlation as well as a strong significance level, $p < 0.01$ between the average values of all the causes of cost overrun and the cost overrun.

5.3.4.3 Regression Test

After performing a correlation test between cost overrun and the 10 independent variables of the causes of cost overrun, regression test will be applied in order to analyse the sensitivity of the relation between cost overrun and the independent variables of the causes of cost overrun. Thus, regression test has been performed to examine the relation between “cost overrun” and each of the 10 independent variables which are “Inadequate project management, Funding problem, Improper cost estimation, Payment delay, Poor tendering document, Inappropriate contractors selection, Lack of contractors experience, Contractors Financing, Frequent design changes during construction phase, and Poor Material Management”. Table 5 demonstrates the outcome of the SPSS regression test between cost overrun and the 10 causes of cost overrun and average of all the causes of cost overrun.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Inadequate project management	.852 ^a	.726	.723	.76663
Funding problems	.825 ^a	.681	.677	.82739
Improper cost estimation	.838 ^a	.702	.698	.79976
Payment delay	.815 ^a	.663	.659	.85021
Poor tendering document	.842 ^a	.709	.705	.79124
Inappropriate contractors selection	.845 ^a	.713	.710	.78455
Lack of contractors experience	.842 ^a	.708	.705	.79140
Contractors financing	.901 ^a	.812	.809	.63606
Frequent design changes	.946 ^a	.896	.894	.47315
Poor material management	.986 ^a	.972	.972	.24351
Average of all cost overrun studied	.896 ^a	.802	.800	.65191

Table 5: Regression's Coefficients (Cost Overrun)

Table 5 demonstrates the followings:

- The variance of 72.3% in the cost overrun can be justified by the inadequate project management variability.

- The variance of 67.7% in the cost overrun can be justified by the funding problems variability.
- The variance of 69.8% in the cost overrun can be justified by the improper cost estimation variability.
- The variance of 65.9% in the cost overrun can be justified by the payment delay variability.
- The variance of 70.5% in the cost overrun can be justified by the poor tender document variability.
- The variance of 71.0 % in the cost overrun can be justified by the inappropriate contractors selection variability.
- The variance of 70.5% in the cost overrun can be justified by the lack of contractors experience variability.
- The variance of 80.9% in the cost overrun can be justified by the contractors financing variability.
- The variance of 89.4% in the cost overrun can be justified by the frequent design changes during construction variability.
- The variance of 97.2 % in the cost overrun can be justified by the poor material management variability

In addition, based on Table 6 which represents the findings of ANOVA test, the significant value is found to be 0.000 which indicates which is considerably safe to duplicate the output of the studied sample in this particular research study over the whole population.

Model		Sum of Squares	df	Mean Square	F	Sig.
Inadequate project management	Regression	121.708	1	121.708	207.084	.000b
	Residual	45.842	78	.588		
	Total	167.550	79			
Funding problems	Regression	114.154	1	114.154	166.754	.000b
	Residual	53.396	78	.685		
	Total	167.550	79			
Improper cost estimation	Regression	117.660	1	117.660	183.956	.000b
	Residual	49.890	78	.640		
	Total	167.550	79			
Payment delay	Regression	111.168	1	111.168	153.791	.000b
	Residual	56.382	78	.723		
	Total	167.550	79			
Poor tendering document	Regression	118.718	1	118.718	189.629	.000b
	Residual	48.832	78	.626		
	Total	167.550	79			
Inappropriate contractors selection	Regression	119.539	1	119.539	194.209	.000b
	Residual	48.011	78	.616		
	Total	167.550	79			
Lack of contractors experience	Regression	118.698	1	118.698	189.518	.000b
	Residual	48.852	78	.626		
	Total	167.550	79			
Contractors financing	Regression	135.994	1	135.994	336.144	.000b
	Residual	31.556	78	.405		
	Total	167.550	79			
Frequent design changes	Regression	150.088	1	150.088	670.407	.000b
	Residual	17.462	78	.224		
	Total	167.550	79			

Poor material management	Regression	162.925	1	162.925	2747.546	.000 ^b
	Residual	4.625	78	.059		
	Total	167.550	79			
Average of all cost overrun causes studied	Regression	134.401	1	134.401	316.249	.000 ^b
	Residual	33.149	78	.425		
	Total	167.550	79			

Table 6: ANOVA (cost overrun)

a. Predictors: (Constant), G.ProjectManagement, G.FundingProblem, G.CostEstimation, G.PaymentDelay, G.PoorTendingDocument, G.ContractorsSelection, G.ContractorsExperience, G.ContractorsFinancing, G.DesignChanges, G.MaterialManagement

b. Dependent Variable: G.CostOverrun

Additionally, Table 7 represents the coefficients (β) of the linear relation amongst the % of cost overrun and the 10 causes of cost overrun with accordance to the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon$$

Yet, through reviewing the Beta values of the 10 causes of cost overrun — Inadequate project management, Funding problems, Improper cost estimation, Payment delay, Poor tendering document, Inappropriate contractors selection, Lack of contractors experience, Contractors financing, Frequent design changes, Poor material management (see Table 7), it is clearly shown that the Beta value for the aforementioned are positive 0.897, 0.898, 0.909, 0.905, 0.875, 0.844, 0.903, 1.014, 1.051 and 1.107 correspondingly, and all have high significance value that is $p < 0.01$. Therefore, in the scenario of altering the % of cost overrun from a classification to one another, each of the 10 independent variables of the numerous causes of cost overrun must be altered through their respective coefficient value of Beta which is illustrated in Table 7.

Model		Unstandardised Coefficients		Standardised Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.589	.194		3.037	.003
	G.ProjectManagement	.897	.062	.852	14.390	.000
2	(Constant)	.534	.219		2.441	.017
	G.FundingProblem	.898	.070	.825	12.913	.000
3	(Constant)	.358	.221		1.621	.109
	G.CostEstimation	.909	.067	.838	13.563	.000
4	(Constant)	.483	.231		2.093	.040
	G.PaymentDelay	.905	.073	.815	12.401	.000
5	(Constant)	.546	.205		2.663	.009
	G.PoorTendingDocument	.875	.064	.842	13.771	.000
6	(Constant)	.733	.191		3.846	.000
	G.ContractorSelection	.844	.061	.845	13.936	.000
7	(Constant)	.428	.213		2.014	.048
	G.ContractorExperience	.903	.066	.842	13.767	.000
8	(Constant)	.057	.180		.319	.751
	G.ContractorsFinancing	1.014	.055	.901	18.334	.000
9	(Constant)	-.157	.136		-1.156	.251
	G.DesignChanges	1.051	.041	.946	25.892	.000
10	(Constant)	-.439	.073		-6.048	.000
	G.MaterialManagement	1.107	.021	.986	52.417	.000
11	(Constant)	.155	.181		.857	.394
	G.CostoverrunCasuses	.997	.056	.896	17.783	.000

Table 7: Regression's Coefficients (Cost Overrun)

a. Dependent Variable: G.CostOverrun

Regression test has been applied to test the sensitivity of the correlation between the averages of all the causes of cost overrun and the cost overrun. Table 5, 6 and 7 illustrate the overall output of the regression test applied.

Table 5 illustrates that **80.0%** of the variance in the cost overrun could be explained by the variability of all the studied causes of cost overrun. Furthermore, the significant value “0.000” that is shown in Table 6 indicates which is significantly safe to duplicate the output of the studied sample in this particular research study over the whole population. In addition, Table 7 views the coefficients (β) of the linear relation among the cost overrun and the average of all the causes of cost overrun as the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon$$

It is observed from table 6 that Beta value is positive **0.997** along with a high significance value for, $p < 0.01$. Therefore, in the scenario of altering the % of cost overrun from a classification to one another, the average of the numerous causes of cost overrun must be altered through their respective coefficient value of Beta.

6.0 Chapter 6: Discussion of Results

In the discussion of result chapter, the outcomes of the quantitative study are being studied and the findings of the relation between the cost overrun and the causes of the cost overrun will be explained. The surveys distributed and their results are used to collect data to quantify each of the independent variable from the perspective focused in this research. The quantifications of the variables made it conceivable to convert the opinions and experiences of previous projects into statistical analysis. Hence, the adopted approach of the quantitative analysis performed an investigation to measure the relationship among the project cost overrun against the variables identified from the literature review as illustrated in the previous chapters.

First of all, as resulted from the reliability test, the measures for each of the independent variables have proven to be representing the independent variables. This can be explained that focus of this study have been affected by similar measures that have been studied. Also, the spectrum of the study covering project main three stakeholders (Clients, Consultants, and Contractors) has resulted in recognizing all the measures by the survey participants. Consequently, the acquired measures from the literature review were demonstrated in the test to be acceptable and adoptable via questionnaires of this dissertation.

Secondly, correlation test was carried out to examine the individual relation and influence of every variable of the independent identified variables in contrast to the specified dependent variable. The results have shown that the project cost overrun variable is being affected in a statically relation with the identified independent variables studied. As the projects studied covers spectrum of variety of the construction industry, the infrastructure projects are proven to be affected by all the studied variables.

The surveys' results were statistically analysed, subsequently the analysis was utilized to examine the regression of the relation of every independent variable of the whole ones with the dependent variable. Mainly, the test has proven that almost 80.0% of the variation in the project cost overrun is determined and justified by the studied independent variables variability. Therefore, the causes demonstrated through the studied independent variables are significant in impacting the project costs and shall be always monitored as an important process for managing out projects. Accordingly, the concerned authorities must concentrate on those explained variables in which the variable of the projects crises are mainly justified via them.

Particularly, the resulted dependence of project cost overrun with every single independent variable will be described in relation to the discussions of the studies in the literature. As for the inadequate project management, the correlation proved that it still affects the projects overrun. Although that it is hard to deny that project management is a key for completing projects on budget, this might a surprising outcome for the authorities that might think that set procedures are enough to control projects. As resulted in the statistical analysis, there is still a dependence on the project management aspects used in the delivery of each project although all have the same defined procedure and settled responsibilities.

As for the funding problems, the results were as expected that delays in the funding of the projects would result in cost overrun consequences. This is mainly because companies mainly deliver projects independently and each is expected to make its own expected profits. Delays in the funding would result that projects are run without plans to reduce the damages of funds shortages. This would normally result in need to spend more budgets in the delivery.

Improper cost estimation by its meaning is a clear reason for any cost problem in the project life cycle. It is mainly that cost cannot be managed, monitored or controlled if the cost was improperly estimated at the first place. The same result has been proven in the statistical analysis of this study that showed that there is a direct correlation between the improper cost estimation and the cost overrun of projects.

Similar to the funding problems correlation to the project cost overrun, the analysis has shown that also the payment delays are affecting the project cost at completion. As client might face problems because of funding shortages, the contractors and consultants would also face problems that affect directly the project delivery. Consequently, problems and challenges would be costly to overcome resulting in higher project cost at completion.

The results of the analysis have also shown that the poor tendering documents result in project cost overrun. There are maybe direct and indirect reasons behind this correlation. This is because proper tender documents would result in different understanding of the project requirements among the stakeholders, and thus creating problems that would require redoing tasks and repeating activities. Also, poor tendering documents would result in improper estimation of the project, which by its turn result in cost overrun.

Wrong contractor on the project would result unsurprisingly in many negative impacts on the project, and definitely the cost. This was confirmed by the statistical analysis that showed that the inappropriate selection of contractor, which will result in having not the best contractor for the job to end up having budget overrun. This is a serious challenge that authorities shall pay attention to, especially with the systematic procedures for qualifying contractors and selecting among them. Normally within the authorities in UAE, the selection is driven by the bidding cost

of the qualified contractors, however, the study is proofing that if a wrong contractor was selected then there is a correlation to cost overrun. Thus, clients shall take this in consideration while looking for the lowest project cost.

Additionally and mainly in connection to the improper contractor selection, contractors with inadequate experience would result also in cost overruns. The statistical analysis has proven the same direct relation between lack of experienced contractor and the consequent cost overrun. This is mainly explained that the contractor would be learning on the job and accordingly the delivery will mostly deviate from the plan. This would result in additional efforts to deliver the project, and thus additional costs. Although authorities in UAE encourage new contractors to join the tenders to enhance the competition, hence, careful attention to the contractors' capabilities is required.

Alike to the proven correlation between the cost overrun and the Payment Delay and Funding Problem factors, the statistical analysis has proven that cost overrun also correlates to the Contractor bad financing factor. This is expected as improper financing by the contractor would lead to changes in the planned activities or tasks during construction, which would lead to overrunning cost to rectify. Additionally, any financing problem would lead to schedule delays, which in return will result in additional cost spending due to the continuity of the overhead costs. Finally, it happens normally that contractor delay in financing the labor and engineers salaries or costs would result in demotivating them, therefore, reducing the productivity.

Unsurprisingly, one of the most affecting variables that the statistical analysis has proven is that the factor of frequent design changes during construction positively leads to project cost overrun. This can be explained due to the consequent repetition of work and activities at site which need

more labor and material expending. Additionally, any changes of design would normally require a lengthy process of approvals among the different stakeholders that can be costly and time consuming especially in the case of huge infrastructure projects with different authorities involvement. These are in addition to the overhead costs that exceed all estimations at the beginning of the project assuming that the design is finalized and frozen.

Materials normally cost a fortune out of the overall cost in the infrastructure projects. Hence, improper management of the material would lead to improper financial management of the project costs. The statistical analysis of this study has showed that the poor management of materials correlates with the cost overrun of the projects. The cost overrun can be a result of many consequences, such as the need to reorder different materials again in the scenario where wrong materials were initially requested. The timing of material request would also lead to cost implications, as ordering the materials earlier than needed would lead to increasing the storing costs, while ordering them later would result in delaying the activities. Additionally, the management of suppliers plays a factor in the material management. This is because choosing a wrong supplier can lead to significant complications that normally require additional funds to rectify and to get the required materials.

0.7 Chapter 7: Recommendations

On the increase of today's complications of the United Arab Emirates (UAE) infrastructure projects, besides the environment in which the current projects are requiring more demands that add additional pressures on project managers to have their projects accomplished within the expected timeline and costs with the required quality. In light of the aforesaid, it is noticed that cost overrun is a key problem that is being experienced in infrastructure projects in the UAE. Till date, numerous infrastructure projects in the UAE are far exceeding their estimated costs which is making it critically challenging to be accomplished within the planned budget. Hence, a number of substantial recommendations are suggested according to the outputs of both literature review and the data analysis of this study, in an attempt to minimise the cost overruns associated with public sector infrastructure projects.

More attention should be paid to adopt an effective strategic planning, since it is the most crucial factor of project management and has the greatest influence on both projects cost overruns and delays. All of the major scenarios taking place in the project lifecycle have to be highlighted and the complete scope of project should be fleshed out prior to coding any single line in the project. Upon the identification of the project's scope of work, then involved stakeholders should sign it off.

Furthermore, having the communication flow seamlessly managed amongst the project's stakeholders is highly recommended, as it is crucial to keep the whole stakeholders of a project at the same page at the aim of avoiding the occurrence of any miss-communication that can result in cost overruns or in other scenarios, breaking a project and delaying its delivery. Moreover, the capabilities of project's contractors should be checked prior to their employment

and their required capabilities and expertise assured to meet the project's requirements. Before hiring contractors in a project, the project manager shall ensure that their cost estimations are realistic besides their ability and experience to work towards deadlines. Adopting the aforesaid would minimise the opportunity of having drags in the project as a result of having inappropriate selection and skill-sets of contractors.

In order to resolve the issue of payment delays that are associated with slow payment schedules with clients in the contract management system in a project, the utilisation of the nonspecific contract templates are recommended to be avoided and instead a careful consideration pertains to the format of the contract should be taken into account where all project's operations expected to take place should be clearly stated. This will assure the effectiveness of the contract management system in terms of having a documented contract that includes all required specifications and requirements of the project.

Likewise, it is recommended to use proper advanced project planning and scheduling tools as well charts especially when dealing with big and complex projects, since it facilitates developing workable schemes of project's operations which eventually enables the successful achievement of project's objectives and helps in avoiding the wrong estimated costs and having an escalation in the idle times for some of the team members as a result of utilizing improper scheduling tools. In addition, a constant control and measure of the overall project's progress is also recommended to be undertaken. Tracking the project's progress including its ongoing numerous tasks along with obtaining various measurable metrics in the project helps in providing early signs of project delays while similarly giving the project's manager opportunities to resolve the issues prior to their emergence.

Another recommendation, construction phase requires a good communication amongst the whole design team in a project. Besides, it is crucial to implement a design process that is appropriately planned where time for correction is sufficiently given and regular reviews are extensively made. Furthermore, the implementation of value management shall be integrated in order to achieve the best cost effective design options. Finally, when designs are completed and well documented, the early sharing of the projects requirements would enable the contractor to better perform the needed material management, which would save the project from a great potential risk of the cost overrun.

8.0 Chapter 8: Conclusion

In this dissertation, the most common factors causing the costs to overrun in public sector infrastructure projects in UAE were studied from the perspective of clients, contractors and consultants who are identified as the main stakeholders in this type of projects. The major aforementioned causes were extensively demonstrated through an intensive literature review based on a number of previous conducted studies in the same domain. The causes of project cost overrun were found to be inadequate project management, funding problems, improper cost estimation, payment delays, poor tendering documents, inappropriate contractors selection, lack of contractors experience, contractors financing, frequent design changes during the construction, and poor material management.

A concentrative research was subsequently undertaken at the aim of exploring the various causes of cost overruns with regards to the public sector infrastructure environment. Therefore, a quantitative analysis was carried out through the implementation of online questionnaire method at the aim of examining the relationship amongst the cost overrun and the causes of cost overrun. Questionnaires were accordingly circulated for data collection targeting the three main stakeholders (clients, contractors and consultants) based on their experience with any of the public sector infrastructure projects within the UAE that had encountered the issue of cost overrun.

The questionnaire's questions consisted of two major sections in which the first section included 10 parts, each contained questions about one cause of the 10 causes of cost overrun. The second section included questions related to the project cost overrun variable. Accordingly, 80 responses had been achieved from key project stakeholders (clients, consultants, and contractors). Then,

these gathered responses were analysed statistically using SPSS software. Three main tests had been performed through SPSS which are reliability test, correlation test as well as regression test. It was illustrated that the studied causes of cost overrun with its independent variables (inadequate project management, funding problem, improper cost estimation, payment delay, poor tendering documents, inappropriate contractors selection, lack of contractors experience, contractors financing, frequent design changes during the construction, and poor material management) correlate with cost overrun variable. In addition, it was proved that **80.0%** of the change in cost overrun can be clarified by the change in the identified and studied causes of cost overrun.

According to the literature review outcomes along with the data analysis of this dissertation, significant recommendations were highlighted at the aim of eliminating the cost overruns related to public sector infrastructure projects. Having a strategic project management effectively adopted in an infrastructure project was recommended as it is the most crucial factor of project management and has the greatest influence on both project cost overruns and delays. In addition, assuring an efficient communication amongst the project's stakeholders was recommended besides ensuring that the capabilities and expertise of the hired contractors do meet the projects requirements and specifications. Furthermore, the utilization of nonspecific project contract templates are recommended to be avoided, instead careful consideration must be undertaken pertaining to the project's contract format which will assure the effectiveness of the project's contract management system.

Likewise, adopting proper advanced project planning and scheduling tools to constantly control, track and measure the overall project's progress was also recommended to be undertaken.

In light of the design matters associated with infrastructure projects, the integration of value management was recommended along with the assurance of effective communication amongst the entire design team and an early sharing of projects requirements after completing and documenting the designs would enable a better performance of project's contractors. This will definitely help in saving significant possible risks of cost overrun.

0.9 Chapter 9: References

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10.0 Appendix

Appendix 1: Questionnaire



Faculty of Engineering

MSc in Project Management

An Exploration of the Causes of Cost Overruns in Public Sector Infrastructure Projects in the United Arab Emirates (UAE): A Stakeholder Perspective

Dear Sir / Madam,

My name is Rim Fanousse, a graduate student from the British University in Dubai. I am conducting a research about “Causes of Cost Overruns in Public Sector infrastructure Projects in the UAE”.

The aim of the research is to study the various causes of cost overruns with regards to the public sector infrastructure environment.

You are kindly invited to complete the below questionnaire based on your experience with any of the public sector infrastructure projects that had encountered the issue of cost over within the UAE.

Kindly be informed that your response to this survey is confidential, and the information provided will only be used for the research on an academic platform.

Many thanks

Please pick a project that you have worked on which experienced cost overrun, and **tick** the best answer for the below question:

1. Please introduce the type of your organisation during the execution of the project:

- 1. Owner
- 2. Contractor
- 3. Consultant

Part One: Based on your experience in infrastructure projects in the UAE:

Please rate the following cost overrun factors according to their “impact” in infrastructure projects in the UAE

Please tick one box for each item that represents your best answer:

SA: Strongly agree; A: Agree;					
N: Neither agree nor disagree;	SA	A	N	D	SD
D: Disagree; SD: Strongly Disagree					

A. Inadequate Project Management

2. Poor project management practices					
3. Lack of communication and coordination amongst the project key stakeholders					
4. Inadequate project preparation and planning					
5. Inaccurate cost as well as time estimates of project					

B. Funding Problems

6. Budget allocation difficulties of owner					
7. Wrong cost estimate at the project initiation phase					

8. Cost inflation during execution					
9. Cash flow difficulties faced by contractor					
C. Improper Cost Estimation					
10. Optimistic cost estimate after design completion					
11. lack of cost estimators' expertise					
12. Inaccurate contingency allowance or assessment of risks.					
13. Inadequate method of cost estimation.					
D. Payment Delay					
14. Owner delay in progress payment for work completed.					
15. Delay in releasing payments to project's subcontractors for the accomplished work					
16. Poor financial control on site					
17. Limited design or engineering budget.					
E. Poor Tendering Documents					
18. Immature tender documents (drawings, bill of quantities, specifications, contracts and legal documents).					
19. Unengaging the project's designer as a consultant					
20. Insufficient consideration of stakeholders' key perspective while developing the tendering document					

21. Shortage of experienced designers in the design firm					
F. Inappropriate Contractors Selection					
22. Inviting inexperienced contractors to participate in the tender					
23. Selecting lowest-price Contractor					
24. Deficient Tender evaluation process by unknowledgeable personnel of the required services					
25. Incorrect anticipation of the contractors' capabilities					
G. Lack of Contractors Experience					
26. Poor organisational structure					
27. Lack of contractor's experience in similar projects					
28. Incompetent subcontractors and suppliers.					
29. Poor preparation and planning by contractor.					
30. Contractor's poor management skills.					
31. Technical incompetence of the contractor teams					
H. Contractors Financing					
32. Contractors' funds are not sufficiently available to allow undertaking projects					
33. Implementing improper project financing practices					
34. ineffective control of both project's costs and					

cash flows during the construction phase					
35. Cash flow and financial difficulties faced by contractor.					
36. Lack of contractor cost planning, monitoring and controlling throughout the execution.					
I. Frequent Design Changes during the Construction Phase					
37. Frequent changes in owners' requirements.					
38. Variations in owner's objectives.					
39. Frequent design alterations.					
40. Change in the scope of the project.					
41. Changes in material specifications.					
J. Poor Material Management					
42. Unreliable material suppliers.					
43. Lack of funds required for material procurement.					
44. Unavailability of materials.					
45. Variations in the attainability of construction materials.					
46. Uncertain deliveries of required materials					
47. The fluctuated prices of materials					

PART Two: Project Budget

Please tick one box for each item:

K. Project Budget

48. What was the size of the project?

1. 5m
2. 20m
3. 80m
4. 150m

49. Were there design consultants on the job?

1. Yes
2. No

50. What was cost at completion compared to estimated budget?

1. 0-2%
2. 3-5%
3. 5-10%
4. 10-20%
5. Beyond 20%

51. What was the main discipline affected by cost overrun (if any)?

1. Material cost
2. Labour cost
3. Engineer cost
4. Overhead cost
5. Equipment cost

52. Based on the causes mentioned above cost overrun could be considered to be an issue in your company

- 1. Strongly agree**
- 2. Agree**
- 3. Neutral**
- 4. Disagree**
- 5. Strongly disagree**

53. If the Above causes reoccurred in other project, the issue of cost overrun will be faced again

- 1. Strongly agree**
- 2. Agree**
- 3. Neutral**
- 4. Disagree**
- 5. Strongly disagree**

Thank you for your time in completing the questionnaire.

Appendix 2: Reliability test output from SPSS

Variable	No. of Cases	No. of Items	Reliability
Inadequate Project Management	80	4	0.969
Funding Problem	80	4	0.970
Improper Cost Estimation	80	4	0.969
Payment Delay	80	4	0.970
Poor Tendering Documents	80	4	0.968
Inappropriate Contractors Selection	80	4	0.973
Lack of Contractors Experience	80	6	0.981
Contractors Financing	80	5	0.961
Frequent Design Changes during Construction Phase	80	5	0.976
Poor Material Management	80	6	0.980
Cost Overrun	80	3	0.951

Appendix 3: Correlation test output from SPSS

Independent Variables	Pearson Correlation values with Cost Overrun	Sig. (2-tailed)
Inadequate project management	0.852**	0.000
Funding problem	0.825**	0.000
Improper cost estimation	0.838**	0.000
Payment delay	0.815**	0.000
Poor tendering document	0.842**	0.000
Inappropriate contractors selection	0.845**	0.000
Lack of contractors experience	0.842**	0.000
Contractors Financing	0.901**	0.000
Frequent design changes during construction phase	0.946**	0.000
Poor Material Management	0.986**	0.000
Average of all cost overrun studied	0.896**	0.000

** . Correlation is significant at the 0.01 level (2-tailed).

Appendix 4: Regression test output from SPSS

Regression's Coefficients

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Inadequate project management	.852a	.726	.723	.76663
Funding problems	.825a	.681	.677	.82739
Improper cost estimation	.838a	.702	.698	.79976
Payment delay	.815a	.663	.659	.85021
Poor tendering document	.842a	.709	.705	.79124
Inappropriate contractors selection	.845a	.713	.710	.78455
Lack of contractors experience	.842a	.708	.705	.79140
Contractors financing	.901a	.812	.809	.63606
Frequent design changes	.946a	.896	.894	.47315
Poor material management	.986a	.972	.972	.24351

ANOVA Test

Model		Sum of Squares	Df	Mean Square	F	Sig.
Inadequate project management	Regression	121.708	1	121.708	207.084	.000 ^b
	Residual	45.842	78	.588		
	Total	167.550	79			
Funding problems	Regression	114.154	1	114.154	166.754	.000 ^b
	Residual	53.396	78	.685		
	Total	167.550	79			
Improper cost estimation	Regression	117.660	1	117.660	183.956	.000 ^b
	Residual	49.890	78	.640		
	Total	167.550	79			
Payment delay	Regression	111.168	1	111.168	153.791	.000 ^b
	Residual	56.382	78	.723		
	Total	167.550	79			
Poor tendering document	Regression	118.718	1	118.718	189.629	.000 ^b
	Residual	48.832	78	.626		
	Total	167.550	79			
Inappropriate contractors selection	Regression	119.539	1	119.539	194.209	.000 ^b
	Residual	48.011	78	.616		
	Total	167.550	79			
Lack of contractors experience	Regression	118.698	1	118.698	189.518	.000 ^b
	Residual	48.852	78	.626		
	Total	167.550	79			
Contractors financing	Regression	135.994	1	135.994	336.144	.000 ^b
	Residual	31.556	78	.405		
	Total	167.550	79			

Frequent design changes	Regression	150.088	1	150.088	670.407	.000 ^b
	Residual	17.462	78	.224		
	Total	167.550	79			
Poor material management	Regression	162.925	1	162.925	2747.546	.000 ^b
	Residual	4.625	78	.059		
	Total	167.550	79			
Average of all cost overrun causes studied	Regression	134.401	1	134.401	316.249	.000 ^b
	Residual	33.149	78	.425		
	Total	167.550	79			

a. Predictors: (Constant), G.ProjectManagement, G.FundingProblem, G.CostEstimation, G.PaymentDelay, G.PoorTendingDocument, G.ContractorsSelection, G.Contractorexperience, G.ContractorsFinancing, G.DesignChanges, G.MaterialManagement

b. Dependent Variable: G.CostOverrun

Regression's Coefficients

Model		Unstandardised Coefficients		Standardised Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.589	.194		3.037	.003
	G.ProjectManagement	.897	.062	.852	14.390	.000
2	(Constant)	.534	.219		2.441	.017
	G.FundingProblem	.898	.070	.825	12.913	.000
3	(Constant)	.358	.221		1.621	.109
	G.CostEstimation	.909	.067	.838	13.563	.000
4	(Constant)	.483	.231		2.093	.040
	G.PaymentDelay	.905	.073	.815	12.401	.000
5	(Constant)	.546	.205		2.663	.009
	G.PoorTendingDocument	.875	.064	.842	13.771	.000
6	(Constant)	.733	.191		3.846	.000
	G.ContractorsSelection	.844	.061	.845	13.936	.000
7	(Constant)	.428	.213		2.014	.048
	G.ContractorsExperience	.903	.066	.842	13.767	.000
8	(Constant)	.057	.180		.319	.751
	G.ContractorsFinancing	1.014	.055	.901	18.334	.000
9	(Constant)	-.157	.136		-1.156	.251
	G.DesignChanges	1.051	.041	.946	25.892	.000
10	(Constant)	-.439	.073		-6.048	.000
	G.MaterialManagement	1.107	.021	.986	52.417	.000
11	(Constant)	.155	.181		.857	.394
	G.CostoverrunCasuses	.997	.056	.896	17.783	.000

a. Dependent Variable: G.CostOverrun