FACTORS AFFECTING CONTINGENCY AMOUNT IN BIDDING FOR LARGE CONSTRUCTION PROJECTS: CONTRACTORS PERSPECTIVE

BY

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A Thesis Presented to the
DEANSHIP OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

DECEMBER 2015

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN- 31261, SAUDI ARABIA

DEANSHIP OF GRADUATE STUDIES

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To

My Beloved Parents

ACKNOWLEDGMENTS

All praise is due only to ALLAH for his guidance and protection throughout the period of my study. I wish to thank my family for their love and support. I would like also to express my appreciation to Prof. Sa’di Assaf, for all his guidance and support.

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ABSTRACT

Full Name : Shadi Suhail Abo Abdo

Thesis Title : Factors affecting contingency amount in bidding for large construction projects: contractors perspective

Major Field : Master of science in construction engineering and management

Date of Degree : December 2015

During bidding stage contractors add contingency amount to their estimate in order to deal with risk and uncertainties. Contractors rely on expert judgment to determine this amount and they add certain percentage to the total estimated price.

In this study, a data from twenty four large building construction projects were collected through a survey. A quantitative methodology based on correlation and regression analysis were applied to quantify the financial impact of risk factors on contingency levels. The results revealed that the variation in contingency could be related to four factors, which are: (1) Adequacy of schedule requirements (2) Confidence in work force (3) Risk involved in investment (4) Overall economy (availability of work).

This research provides practical statistical methodology for the determination of contingency amount in construction. A systematic description for the development and validation of the model is provided along with the results and discussion.

ملخص الرسالة

الاسم الكامل : شادي سهيل أبو عبدو

عنوان الرسالة : العوامل المؤثرة في تقدير مبلغ الطوارئ في المشاريع الانشائية

التخصص : هندسة وإدارة الانشاءات

تاريخ الدرجة العلمية : كانون أول 2015

في مرحلة تقديم العطاءات للمشاريع الانشائية يقوم المقاولون بإضافة مبلغ للطوارئ وذلك بعد إتمام عملية تقدير التكلفة للمشروع. يعتمد المقاولون في تقدير هذا المبلغ على الخبرات السابقة ويكون هذا المبلغ عادة بصورة نسبة من القيمة الاجمالية للعقد. في هذه الدراسة، تم جمع البيانات عن 24 مشروع انشائي كبير وتم دراستها وتحليلها باستخدام تقنية التكامل الخطي. وقد تم استخدام التحليل الخطي لتقدير حجم التأثير المالي لعوامل الخطر المختلفة على نسبة الطوارئ في المشاريع المشاركة في الدراسة. وقد أظهرت النتائج ان التغير في نسبة الطوارئ يمكن ايعازه الى اربعة عوامل هي:

(1) متطلبات الجدولة الزمنية للمشروع

(2) تقييم الثقة في العمالة المتوفرة

(3) تقييمك لمخاطر المشاركة في الاستثمار

(4) تقييم للوضع الاقتصادي الكلي (توافر العمل)

بناء على ما سبق فان هذا البحث يقدم منهجية عملية معتمدة على الإحصاءات لتقدير حجم مبلغ الطوارئ اللازم للمشاريع الانشائية. كذلك يقدم شرح وافي ومنتظم لعملية تطوير النموذج وكذلك لعملية التأكد من فعاليته.

CHAPTER 1

INTRODUCTION

During the bidding stage, contractors add a contingency markup amount to their estimated prices. Typically, contractors use an arbitrary percentage of the total estimated price. Contractors factor in this amount to deal with risks and uncertainties. The contingency percentage could be crucial for the success of the contractor and hence for the project. A high percentage may lead to losing the bid, and a low percentage may contribute to the project's cost overrun. The contingency amount has a direct effect on the total price of the project; therefore it remains the focus of attention for owners.

This study identifies and evaluates the risk factors considered by contractors in Saudi Arabia during their estimation of contingency. In addition, it investigates the relationship between the risk factors and the contingency decision. A regression model will be developed in order to quantify the impact of risk factors on the contingency amount. The model could be used as a tool to aid the estimation process for future projects.

The thesis layout is comprised of four chapters. The first one is the introduction chapter in which background information about the topic is provided. In addition, it introduces the research question, objectives, and limits. The second chapter presents a literature review of previous research that supports the research problem and the research approach of this study. Chapter 3 provides a systematic description of the data collection procedure and the analysis process. Finally, chapter four shows the steps of the analysis, the model development and provides a discussion for results.

1.1 Background

In construction projects, the bidding process is considered to be the most critical stage in the life cycle of any project. It is the phase of the project where the profit of the contractor is firmly determined. Notably, the amount of profit plays a vital role in the success of the bid, as well as in the success of the construction company in order to continue expanding its business (Arslan et al. 2006). Bidding for construction projects is a complex process involving many different parties, such as the owner, engineers, general contractors, subcontractors, material suppliers, and manufacturers etc. (Halaris et al. 2001).

During the bidding stage, contractors are forced to make critical decisions regarding the risks of cost overruns and compliance with competition requirements. Indeed, most contractors use an arbitrary percentage of their bidding prices as a contingency fund (Thal Jr. et al. 2010). Contractors strive to develop accurate budgets to mitigate risks and to stay competitive. As well, budgets are important tools used by mangers to achieve the project's objectives (Ford 2002). The traditional method used by contractors is to rely largely on expert judgment to produce an arbitrary contingency percentage of the total estimated price. The main drawback of this technique is the subjectivity of the decisions taken. Besides, experts may vary in their knowledge, skills, and experience (Burroughs and Juntima 2004).

Much research has been conducted to improve the methods of determining the contingency amount. According to Bakhshia and Touranb (2014), there are three main methods developed to determine the contingency amount for construction projects; these are the deterministic, probabilistic, and modern mathematical methods. This study proposes a quantitative analysis methodology to determine the effects of risk factors on the bidding contingency. Correlation and regression analysis techniques will be used to determine the significant factors, and to develop a regression model. The results of this study would support contingency decisions and allow for evaluation of the impact of risk factors. Note that Burroughs and Juntima (2004) concluded that regression models are an excellent alternative or supplement to the traditional methods used to determine cost contingency.

1.2 Definition of contingency

There are different definitions associated with contingency in construction. The Association for the Advancement of Cost Engineering (AACE) provides comprehensive definition for contingency as “An amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs. Typically estimated using statistical analysis or judgment based on past asset or project experience.” In this definition, contingency doesn’t include major scope changes, extraordinary events, or escalation and currency effect.

According to the Construction Industry Research and Information Association (CIRIA) contingency can be categorized into three types, (1) Tolerances in the specification, (2) Float in the schedule, (3) Money in the budget. PMI (2004) defines contingency as the additional amount of time or money added to the estimate to reduce the impacts of potential risks or uncertainties.

In this study, contingency is the amount of money added by the contractor to their estimate, usually as a percentage from the total contract, in order to reduce the implications of risks and uncertainties during bidding stage.

Contingency has been defined as the amount of money or time needed above the estimate to reduce the risk of overruns of project objectives to a level acceptable to the organization (PMI 2004)

1.3 Objectives

This research will highlight the main factors considered by contractors in pricing their bids. These factors are important for both the client and the contractor as they may contribute to cost overruns. A regression model will be developed that is hoped to be used as a tool assessing the contractors to predict the amount of contingency funds. The study will also benefit the owners to determine and control the amount of reserve required to be added to the estimated project cost.

The objectives of this study are:

1. Identify the major factors affecting the amount of contingency on large building construction projects.

2. Develop a regression model comprising the major identified factors to support contingency decision making during bidding stage.

1.4 Research Limitation

Listed below are the limitations of the research:

1. The research will be limited to large building projects.
2. The study will be carried out in the eastern province region of Saudi Arabia.
3. Research only deals with the contractors perceptions.
4. Contract type lump sum contracts.

1.5 The Outline

This thesis is structured as follows:

Chapter 1 Introduction: provides an overview of contingency in construction. The chapter headlights the main goal of the study and identifies the research problem. It also provides brief background on the topic and the research approach. Moreover, the specific objectives of the study were introduced.

Chapter 2 Literature Review: this chapter provides the fundamental information about the topic of the study. In addition, it provides a summary of previous research that supports the objectives of thesis. The topics covered in this chapter includes contingency, risk factors, and risk assessment and mitigation in construction.

Chapter 3 Risk factors in construction: provides background information about risks in construction. It includes a discussion about risk factors that comprises the questionnaire. It declare that these factors worth being in the survey and ensure no repeating factors are included.

Chapter 4 Methodology: This chapter clarify the research tools and explain why they are suitable for research problem. It also provides breakdown of the methodology employed to achieve the thesis question. In this chapter the questionnaire development was described besides the sampling procedure, data collection, validation process.

Chapter 5 Analysis and Results: This chapter concludes the analysis procedures and the results of the study. In addition, it provides descriptive analysis measures for the collected data. It presents a systematic description of the analysis performed including correlation analysis, linear regression model development, and validation process.

CHAPTER 2

LITERATURE REVIEW

2.1 Risk Factors in Construction

William and Ashley (1987) studied the impact of various construction clauses on the project performance. The study analyzed the impact of two types of contracts and 96 clauses on 36 large completed construction projects. The project performance were evaluated based on six measures: cost, schedule, quality, safety, and owner and contractor satisfaction. The study identified the clauses that have the most effect on project performance.

Kangari (1995) investigated the risk management altitude of large construction companies in U.S. 100 contractors were surveyed on the current practices. The results compared with ASCE previous study. The survey revealed that contractors in recent years are more willing to consider contract and legal problems as a shared risk with the owner.

Irtishad (1992) proposed a simulation-based method to allocate contingency by work package instead of allocate it to the entire project. The method was based on the historic data of the company. The contingency is represented by the ratio of actual cost to estimated cost for each work package. A simulation distribution is generated for each work package based on three ratios obtained from historic data. The three ratios are optimistic, pessimistic, and the most frequent. The simulation process can produce different outcomes and determine the probability for each one.

Shash and Abdul-hadi (1992) conducted a study to determine the factors affecting contractors' mark-up size decision of contractors in Saudi Arabia. A questionnaire was distributed to contractors where they asked to evaluate the relative importance of 37 factors on mark-up decision. The results revealed that the following factors the most important: (1) size of the contract (2) availability of required cash (3) competition (4) labor availability and (5) profitability.

Dulaimi and Shan (2010) investigated the factors that affect the size of mark-up decision. A survey was conducted consists of 40 factors identified through literature review. The results showed that contractors have different altitude regarding mark-up size decision in corresponding with their size. The survey revealed that smaller contractors are more concerned about their own company finance status. On the other hand, larger contractors are more concerned about the type of work.

Ling and Liu (2004) investigated the most important factors considered by successful contractors in make-up size decision. A survey was conducted to evaluate 52 factors. The results showed that 21 factors are found to be significant. The owner characteristics are found to be the most important. Moreover, the study revealed that contractors who are more profitable were more concerned about factors related to schedule, cost, and quality of the project.

Akinci and Ficher (1998) discussed the risk factors that contribute to contractor's cost overburden. The study provides detailed description of the sources of these risks. In addition, it investigate their effect on the cost estimate and on the final price of the project. These factors included the cost estimator characteristics project design, and the project environment.

Chan and Au (2009) investigated the factors that affects the contractor decision for pricing time related risks. A questionnaire study was conducted to collect data from contractors. The respondents were asked to evaluate the risk factors and to provide their feedback about the normal price in the absence of this specific risk. The results revealed that one factors can both inflate or deflate the prices according the contractor size. The study assisted that owners should follow an effective contract strategy.

2.2 Contingency in construction

Smith and Bohn (1999) investigated the use of contingency in small construction firms. The study reviewed the literature on risk classification and mitigation techniques. Then, interviews were conducted with construction managers to investigate current risk mitigation techniques. The findings from the literature and the interviews were compared and the results showed that the contingency is predominately used in small projects. Another finding was that contingency line item is not used in the situations of competitive bidding.

Laryea and Hughes (2011) conducted a study to compare the analytical approaches developed by academic researchers for risk analysis with the actual practices followed by the contractors in the bidding process. The findings identified three tiers of risk apportionment in bids. The analysis of past projects data showed that average risk allowances of 1-2% were used. The findings of the study reported that contractors may not use contingency allocations to approach risk, instead risk is priced through contractual mechanisms.

Laryea and Lubbock (2014) carried out a research studying the main barriers affecting pricing of tenders by subcontractors. 94 subcontractors were surveyed and five of them were interviewed. The findings showed that the main barriers to provide better prices were related to "quality of documents, bidding time, competition, resource levels, information and communication technology, unethical behavior by the contractor, uneven collaborative relationships, input specificity, level of relationship that exists, and the time to assimilate and provide the output response." The study suggested that addressing these issues by contractors and clients could lead to better project outcomes.

Ford (2002) modeled the decision making process used by project managers to manage contingencies and achieve project objectives. Data was collected that captures the characteristics of contingency management. In addition, a dynamic simulation model is described. Two types of management strategies, passive and active, have been reported and tested using the proposed model. The results showed that poor performance of the aggressive strategy although it was more rebuts than the passive strategy.

Thal et al. (2010) proposed a model to predict the amount of contingency required to mitigate the risk of cost overruns. The model was developed from the analysis of 203 air force construction project. The variables considered in the model were classified as project characteristics, design metrics, and contracting influences. The application of the model showed that 44% of cost overruns were predicted compared to 20% of the current practice. In addition, the average contingency error was reduced from 11.2 to 0.3%.

El-Touny et al. (2014) conducted a research to study the impacts of risk factors on the cost contingency of highway projects. 90 construction companies and experts in Egypt were surveyed on 175 factors that affect cost contingency. The Analytical Hierarchy Processes is used to analyze the collected data.14 factor were reported to be the most important. Using data of completed projects, the developed model was tested, where it showed 96.31% matching with actual contingency for real projects.

Chan and Au (2008) investigated the behavior of different sized contractors in pricing weather risks. A survey was conducted to study the impact of different project scenarios. The results showed that project value and contract period are important factors in weather-risk pricing behavior. In addition, medium-sized contractors have showed constant pricing behavior, while small and large contractors behaved differently under different project scenarios.

Chan and Au (2008) studied the factors influencing the contractors when pricing of time related risks. A survey was conducted to collect data from building contractors in Hong Kong. The contractors provided their inputs about the importance of each factor, in addition they were asked to state the implication of each factor. The results showed that an individual factor might inflate and deflate the prices.

Günhan and David (2007) proposed a methodology attempting to reduce the construction contingency budget of the owner. Instead of allocating fixed amount of contingency, the proposed method analyzes historical data to identify the problematic items and takes the necessary measures. The proposed methodology was applied to nine parking lots projects. The results indicated that the owner could minimize his contingency following such systematic approach.

Wang and Chou (2003) conducted case studies to identify risks implied by the contract clauses, and to analyze their influence on the contractors' risk handling strategies. The results showed that if risks are controllable by the contractor, the owners tend more to allocate them to the contractor. The results furthermore indicated that, in case of uncontrollable risks contractors have more tendency towards passively retaining the risk rather than actively transferring it. In contrast, in case of controllable risks the contractors tend to take the necessary measures to reduce its impact.

Sonmez et al. (2007) conducted a research to determine the impacts of risk factors on the financial aspects of bidding stage of international projects. Data of 26 construction projects from 21 countries were collected and analyzed using correlation and regression analysis. The findings showed that material availability, type of contract, and advanced payment amount are the major factors affecting contingency. The major factors were included in proposed model, which was developed to support contingency decisions in the bidding stage.

Chan and Au (2007) studied the behaviors of contractors in pricing weather risk. Data from questionnaire survey were collected and analyzed. The results showed that small contractors have more tendency to absorb weather risks. The study concluded that transferring to the contractors is not cost effective to the owner.

Ling and Liu (2007) investigated the major factors considered by successful contractors that affect the mark-up decision. A survey was conducted on 52 factors that were collected from literature. The analysis results showed that the most significant factors are payment record, size, and type of client.

CHAPTER 3

Risk Factors

This chapter discusses the risk factors in construction projects during bidding stage. The study is concerned about risks from the contractor's perspective. The risk factors have been collected through a literature review of previous studies. These factors are assumed to have a potential effect on the contractors' contingency decision making.

There is a proportional relationship between the amount of risks and uncertainties in a construction project and the contingency percentage. Generally, contractors increase their estimated prices to deal the unknowns, however contractors must take some risks in order to stay competitive in the market. The decision of taking the risk or avoiding it is essential for the success of the contractor organization. Successful contractors have built strategies and attitudes to identify and control different risks (Kim and Reinschmidt 2011).

3.1 In this study, the risk factors are classified into risks related to; the project generally, project documents, the contractor home company, the bidding situation, the overall economic situation, and finally the site conditions.

3.2 General Project Risk Factors:

General project risks are risks in construction projects that can be related to the project in general. These risks could be find in any construction project. The contractor can identify these factors by collecting general information about the project. The identification of the general project risk factors requires the reference to research conducted to study bid and no bid decision.

3.2.1 The adequacy of schedule requirements:

Owners incur losses due to delays on delivering their construction projects (Luu et al. 2009). Construction contracts are designed to allocate the risks of delay to contractors (Zhang et al. 2016). During bidding stage, the contractor determines the price of risk transfer. Therefore, it is crucial for the owner to understand the factors influencing the contractor price for the risk allocation (Chan and Au 2009). The contractor estimation of time related risks varies due to numerous internal and external factors (Shash and Abdul-Hadi 1992).

During the bid preparation, the contractor allocate the quantity and quality of resources required to complete the project (Akintoye 2000). When the owner requires to complete the project in a shorter period of time that will force the contractor to use more resources or to improve its quality. The contractor will be forced to increase his production rate by hiring external resources, increasing the working hours, or by using new advanced technologies to speed up the construction process. To achieve the time requirement of a project the contractor will be required to pay more in shorter period of time. The contractor decision for this factor will be influenced by his company size and capabilities, so that the sample companies for this study was chosen to be relatively with the same size.

The implications of the delay are deferent from one bid and the other. The contract extension of time clauses determines the entitlements of the contractor when a delay happens. The contractor would have burdened further risks; in case the owner chose to remove the contractor's extension of time entitlement (Chan and Au 2009).

When evaluating the time and schedule requirements the contractor consider the size of contract in reference with the available resources. In addition, the contractor perceives the implications of the delay according to the contract clauses.

3.2.2 The quality requirements:

Many definitions of quality have been presented in literature. Crosby (1979) stated quality as "conformance to requirements," while Deming (1986) defined it as the "uniformity with respect to a correct target." In addition, Juran and Gryna (1980) presented the quality to be "fitness for purpose". In the construction industry the quality is defined as the ability to achieve the owner pre constructed requirements (Kazaz et al. 2005). The main concern of contractors in construction projects is to achieve the balance between quality requirements and the costs associated with it (Heravi and Jafari 2014). The failure to achieve the required levels of quality results in losses of money and resources. Due to quality failures the contractor incurs the costs of rework or maintenance (Kazaz and Birgonul 2005b). The costs of quality are not limited to failure costs, some studies divide the quality costs into three categories prevention, appraisal, and failure costs, although some construction organizations consider only the failure costs (Heravi, and Jafari 2014). On the other hand, Davis et al. (1989) divided the quality costs into two categories, the cost of managing the quality activities and the costs of correcting work defects. In general, the aspects of quality systems in construction involve the quality assurance, quality control, and quality management activities. These activities might be considered as inputs to the quality system while the lack of quality or the quality failure might be considered to be the negative outputs (Davis et al. 1989).

When the owner specifies high quality standers for his project the contractor incurs additional costs adhering to these standards (Duttenhoeffer 1992). The contractor assumes that higher levels of quality will be associated with greater rates of rejection of works, materials, and workmanships. It is also in the concern of the contractor that quality activities may result in reduction of his production rates. Lower production rates prevent the contractor from utilizing the full capacity of allocated resources in the project. The performance of quality activities may result in interruption of the construction operations. The contractor will incur the costs of delay in addition to the costs of idle resources.

Generally, quality has a direct effect on the cost of the construction project ((Duttenhoeffer 1992)). The contractors increase their prices to accommodate the costs of the required quality standards. The contractor's experience in the similar work and his confidence in performing the job plays a major role in reducing the costs of quality.

From the literature, it is clear that there is a direct relationship between the quality and the costs of construction. This study investigates the relationship between quality requirement and the contingency amount used by the contractor. It is assumed that adhering to higher quality standers will upsurge risks and uncertainties on the contractor side. With the increase of risks, the contractor may increase the contingency percentage.

3.2.3 The safety and environmental requirements:

The safety management of a construction site involves the process of control policies, procedures, and practices related to safety (Wilson and Koehn 2000). Numerous construction firms around the word have utilized safety and environmental management systems to reduce accidents and injuries in all phases of the construction project (Choudhry et al. 2008). According to ASCE Policy "construction site safety requires attention and commitment from all parties involved". In addition, the owners realized that they wouldn't be detached from the costs of injuries in the construction site. For this purpose, some owners try to play an effective role promoting safety in the construction site. Studies showed that the involvement of owner to ensure the safety of the construction site can significantly improve the safety of the project (Gambatese 2000). The regulations of safety and environmental for a construction project varies according to the nature of the project. Owners may establish a certain safety regulation that contractors must adhere to. Some projects may involve risky activities that require robust safety measures to prevent accidents. The production rate to finish the dangerous activities might be lowered by the safety measures that must be taken.

During bid preparation, contractors take in their consideration the costs of accidents and injuries. These costs involve insurance, medical expenses and losses in productivity rates (Irizarry et al. 2005). Few studies have been conducted to quantify the loss in productivity due to unsafe conditions. Irizarry et al. (2005) conducted a study to measure the effect of safety and environmental variables on the duration required to accomplish the construction tasks. The results of the study showed that task duration is significantly affected by the safety of the task.

Furthermore, the quality of the work performed will suffer due to the unsafe conditions of the project. Wanberg et al. (2013) studied the relationship between quality and safety. The results showed that there is a direct relationship between the rate of injuries and the rework amount. It also showed a positive correlation between the rate of first aid injuries and the number of defects. The study concluded that the positive correlation between injuries and rework is due to that rework involves destructive activities, rush time and schedule pressure.

This study will investigate whether the contractors in Saudi Arabia perceive safety and environmental variables as a potential risk that can influence their contingency decision making.

3.2.4 The type of equipment required

This study is restricted to the construction of buildings projects. The equipment risk factor may be more extreme in the case of projects controlled by equipment production rates such as tunneling and paving.

Risks involved with construction equipment include the costs incurred when an equipment breaks down or fails. The cost of equipment down time can be categorized into, cost of resources needed to repair the equipment and the cost of failure or delay that impact the company as whole (Vorster and Garza 1990).

Some construction projects contain design complexities that may require specialized equipment and advanced technologies. The risk involved in such project is that its success depends largely on the performance of the new technologies and equipment (Aklnci and Flscher 1998).

The equipment required for a project wouldn’t have large impact on the contractor price at bidding stage unless the project has special requirements. It is expected that the contractor will perceive risk of equipment only in the case where the project performance depends on the production rate of the machines.

3.2.5 The type of material required

The material in construction projects play an essential part in the budget. The use of locally available material may considerably reduce the budget and produce cost savings. Using locally available material results in a reduction in the delivery time and a great cut in the transportation, lober, and damage costs.

Supplying of construction material is exposed to high financial risks due to the nature of importing business (Chen et al. 2012). Thomas et al. (1989) stated that poor material management leads to losses in construction labor productivity. In contrast, previous studies indicated that efficient material management could yield significant costs savings in construction projects (Chen et al. 2012).

Another risk factor related to material that contractors should consider during did preparation is the material volatility. Construction material volatility can impact the availability and the cost of materials required to finish the construction project.

The materials required to complete the project play a big role in the price of the contractor and hence in the contingency decision. Contractors may use higher contingency rates to deal with the risks of material unavailability and the risks of importing materials that is not locally available. Contractors may also increase the contingency amount to deal with the loss in productivity in case of using new types of materials.

3.2.6 The owner reputation

The owner of a construction project is the party who pays for the services provided to complete the project. These services include the planning, design, and construction. The owner may have his in-house engineers or having no engineering facility in his organization.

The owner plays a major role in the success of the construction project. The role of owner is vital in all construction phases, pre design phase, design phase, construction phase, and post construction phase. Bubshait and Al-Musaid (1992) stated that owner involvement can improve the quality of the construction project. Chen et al. (2014) reported that owner-contractor conflicts impact the project cost performance.

The owner reputation and his financial performance is the concern of the contractor during bid preparation. When the client faces financial issues, it will impact the contractor's payments. Furthermore, contractors may strive to work with owner who has good financial performance. In results, contractor may use less contingency amount to be more competitive in the bid.

3.3 Project documents:

Project risks related to the project documents include the contractor perspective to hazards and uncertainties generated from drawings and design documents provided by the owner. In this category of risks, contractor evaluates the quality of the design and the proficiency of the designer. The design information are included in the bid documents using bill of quantities, drawings, and specifications. The documents in the construction project are the information source for the project knowledge (Al Qady and Kandil. 2013). Project design drawings are one of the main parts of the bid documents. The contractor perceives the first impression about the project from the drawings. High quality of design drawings may decrease the ambiguity involved in the project, therefore contractors produce accurate estimations.

On the other hand, the designer qualifications and his experience can have an effect on the contractor price. When the owner hire unqualified designer, more design changes will be issued. Design changes may affect the contractor productivity and disturb the construction process. Contractors about the designer role in the project so that it is assumed the designer qualification may impact the bid price.

Another risk factor related to the project document is the complexity of the design. The contractor may be required to utilize new construction methods, get new advanced equipment, or hire more skilled workers to perform the work. This obligate the contractor to waste more resources and can impact his price.

Furthermore, the owner may prompt special requirements additional to the design. These requirement might include changes in the scope of the work, changes in the use of the building, specifying special material and subcontractors, or modifying the building materials. The owner requirement may impact the contractor price for certain items in the bid or for the all project in general.

3.4 Company Risk Factors:

The company risk factors are risks related to contractor home company such as; availability of required cash, certainty in the cost estimate, experience in similar projects, the confidence in work force, availability of qualified staff, past profit in similar jobs, current workload, reliability of subcontractors, and the portion subcontracted to others. In this category of risks, the contractor evaluate his company experience, readiness, and qualification to achieve the project goals. When the contractor is more confident with his company capabilities he would be encouraged to take more risks. The company situation during bid preparation has an important impact on the risk management strategy. In order to be more competitive, the contractor may reduce the contingency amount allocated for risks related to his own company.

3.5 Bidding Situation:

In order to stay and survive in the market, construction firms usually take a lot of risks to be competitive and win the bids. The level of competition determines how far the contractor can be conservative in his proposal. Competitive bid proposals can be more risky for the contractor. It is expected that higher levels of competition will force the contractor to reduce his price and therefore the contingency used in the bid.

Another aspect of the bidding situation, is the time allowed to submit the bid proposal. When a plenty of time is available the contractor can produce more accurate estimation of the proposed work. In contrast, when the time is short contractors will use assumptions and they might be more conservative. The bidding situation is also characterized by the bond capacity, the document price, and the prequalification requirements.

3.6 Economic Situation

The economic situation at the time of bid preparation has a great influence on the contractor decision. The risk involve in the investment factor gives a general indication about the political risk, financial risk, legal risk, and policy risk. This factor measure how contractors impacted by the economic situation in the country of work. The contractor has to also consider the risk of losing other opportunities, as well as the risk of not getting other jobs.

Factors related to the economic situation, evaluate the effect of the availability of resources such as; equipment, labor, and material on the contractor decision of contingency. The fluctuation in the prices of resources puts more on the contractor. Also the changes in the governmental requirement and regulation might impact the contingency decision.

3.7 Site Risk Factors:

Managing the site risk conditions is very important for contractors working in Saudi Arabia. Harsh environment, especially in the summer time, reduces the productivity of labor and may cause a delay. In addition, unknown geological conditions present large source of risks and uncertainties. The owners may choose to move the risk of weather and the geological conditions to the contractors. In this case, contractors may use larger contingency to deal with these risks. Another factor related to the site risks is the project location. The project location determine the difficulty of transporting material and labor to the site. The contractor may use contingency to deal with unknown costs of transportation and storing material.

CHAPTER 4

Research Methodology

4.1 Methodology

To achieve the paper's objectives, appropriate research tools have been selected. The tools will be used systematically to test the hypothesis statements shown in Figure 1. Initially, the factors affecting cost contingency will be identified through a literature review. The factors will be used to prepare a preliminary questionnaire on which a pilot test will be conducted. The pilot test will include interviews with experts to assure the effectiveness and clarity of the questionnaire items. When the questionnaire is finalized, it will be distributed electronically and by hand. The research population will comprise large building construction contractors, classified as grade 1, 2, or 3, and who have adequate experience working in Saudi Arabia. Statistical analysis using SPSS software will be performed to study and test the hypotheses' statements. The analysis results will identify the contingency factors that affect the bid price. These factors will be used to develop a regression model. The model will then be tested against the minimum and maximum entered data. The impact of different factors will be compared using the sensitive analysis technique.

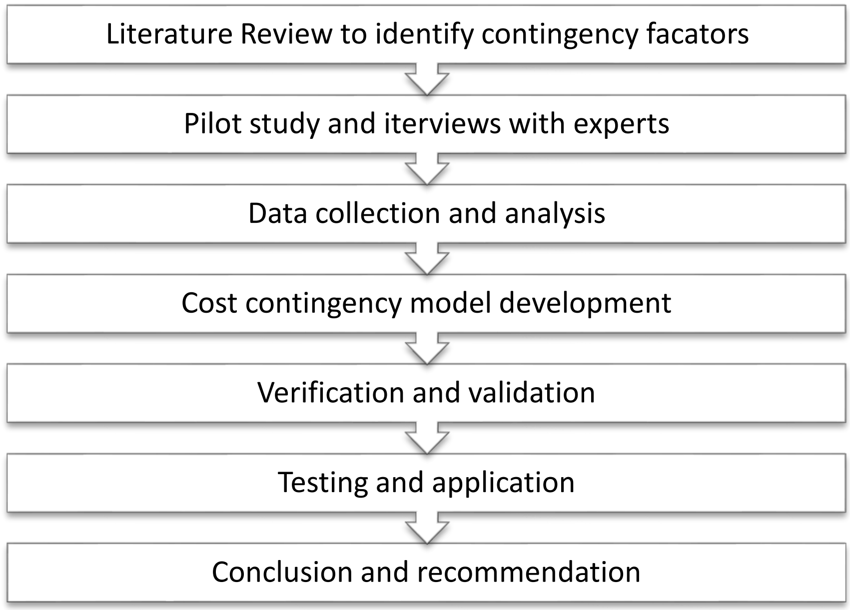

Figure 1 Proposed work flow chart

4.1.1 Sampling

The research will be constrained to the eastern province of Saudi Arabia. The survey will include contractors who involved in pricing activities during biding stage in their companies.

4.1.2 Data Collection:

Data will be collected through the prepared questionnaire survey to assess the main risk factors affecting contingency. The questionnaire will comprise two sections, the first one will ask contractors to provide input about company experience, project size, contract type, delivery method, contingency amount used. The second one seeks to evaluate specific contingency related factors using 5 points ranking system, with “one represents the best condition and “five” represents the worse condition. The evaluation criteria to be used to assess each factor will be as follows:

1= The best 2= V. Good 3= Good 4= Bad 5= Worse

A pilot study test will be performed on the preliminary version of the questionnaire to insure its effectiveness. This study will take a form of structured interviews with experts in the construction industry in Saudi Arabia.

4.1.3 Data Analysis:

The main risk factors impacting cost contingency will be identified using statistical analysis techniques. Since in this research 5 points ranking system have been utilized, it is important to evaluate the collected data in correspondence to this ranking system. To help in this, the following formula is used to calculate the importance index:

$$Importance\ index = \frac{\sum_{i=0}^{4} a_i x_i}{4\sum_{i=0}^{4} x_i} \times 100\%$$

Where:

$i = response\ category$: 0,1,2,3,4

$a_i = responses\ weight$

$x_i = represent\ frequency\ of\ i$

X0 = frequency of “The Best” response corresponding to a0 = 4

X1 = frequency of “Very good” response corresponding to a1 = 3

X2 = frequency of “Good” response corresponding to a2 = 2

X3 = frequency of “Bad” response corresponding to a3 = 1

X4 = frequency of “Worse” response corresponding to a4 = 0

4.1.4 Correlation Analysis:

The linear relationship between risk factors and contingency amount is determined using the Pearson correlation coefficient. The results of correlation will determine the factors that will be included in the regression model (Ergin 2005).

4.1.5 Regression Model

Linear regression analysis will be performed to detriment the relation between risk factors and the contingency amount. Risk factors that are not contributing to the model will be removed by backward elimination technique. The P value will be used to determine the significance of each factor. The elimination will be repeated until all coefficients had a P value less than 0.1. Finally, the determination coefficient (R2) for the final regression model will be calculated. The determination coefficient will provide an indication about how well the regression model represent real data. (Sonmez et al. 2007).

4.1.6 Validation of the model

The developed model will be analyzed to determine it goodness of fit. The following methods will be used to validate the model:

1. Test the model against the minimum and maximum contingency results.
2. Validation using R2.
3. Fivefold Cross validation.

4.2 The Design of Preliminary Questionnaire

An extensive literature review was conducted to collect the main factors affecting the contingency percentage used by contractors. These factors are then presented in the initial questionnaire in order to be evaluated by the contractors. The developed questionnaire was categorized in three sections. The first one included questions to collect general information about the respondent and the company he represents. This information included data such as; contacts, education level, years of experience, position, company grade and company experience.

In the second section, respondents were asked to provide financial information about one of the projects they were involved in pricing. The respondents were asked to provide data such as; project size, contract type, project delivery method, performance bond amount, advance payment amount, and finally the contingency amount as a percentage of the total contract.

In the third section, respondents were asked to evaluate the project conditions at the time of bid pricing based on 34 risk factors. The evaluation was based on a rate from one to five. The questionnaire was left open ended so that respondents can add any factors they think they were not included in the evaluation.

4.3 Conducting a Pilot Study

The main purpose of the pilot study is to run a trial to test the preliminary questionnaire. It allows experts to examine the clarity, integrity, and effectivity of the questions (Naoum 2007). The preliminary questionnaire was distributed to a limited group of professional engineers and project managers with long experience in construction, specifically, in bid pricing and cost estimation. Two experts, with minimum 20 years of experience for each, contributed in the review process through interviews. They were asked to review and comment on the questionnaire quality.

The pilot study ensured that questions are clear and guaranteed full understanding from respondents' side. Experts' comments and modifications were considered in the final version of the questionnaire. According to their feedback, the questionnaire was provided in Arabic and English because the majority of population speak Arabic as first language. Furthermore, the risk factors were reviewed to guarantee covering the most important factors affecting contingency and to avoid repetition. Other comments included elimination, adding, changing of some of the questions, or providing additional explanations.

Table 1 Final Risk Factors

	1	2	3	4	5
General Project Risk Factors:					
a. Adequacy of schedule requirements	☐	☐	☐	☐	☐
b. Adequacy of quality requirements	☐	☐	☐	☐	☐
c. Adequacy of safety and environmental requirements	☐	☐	☐	☐	☐
d. Type of equipment required	☐	☐	☐	☐	☐
e. Owner	☐	☐	☐	☐	☐
Project documents:					
a. Quality of drawings	☐	☐	☐	☐	☐
b. Designer	☐	☐	☐	☐	☐
c. Design complexity	☐	☐	☐	☐	☐
d. Owner special requirement	☐	☐	☐	☐	☐
Company Risk Factors:					
a. Availability of required cash	☐	☐	☐	☐	☐
b. Uncertainty in cost estimate	☐	☐	☐	☐	☐
c. Similar project experience	☐	☐	☐	☐	☐
d. Confidence in work force	☐	☐	☐	☐	☐
e. Availability of qualified staff	☐	☐	☐	☐	☐
f. Need for work	☐	☐	☐	☐	☐
g. Past profit in similar jobs	☐	☐	☐	☐	☐
h. Current workload.	☐	☐	☐	☐	☐
j. Reliability of subcontractors	☐	☐	☐	☐	☐
k. Portion subcontracted to others	☐	☐	☐	☐	☐
Bidding Situation:					
a. Competition	☐	☐	☐	☐	☐
b. Time allowed for submitting the bids	☐	☐	☐	☐	☐
c. Required bond capacity	☐	☐	☐	☐	☐
d. Bidding document price	☐	☐	☐	☐	☐
e. Prequalification Requirements	☐	☐	☐	☐	☐
Economic Situation:					
a. Risk involved in investment	☐	☐	☐	☐	☐
b. Availability of equipment	☐	☐	☐	☐	☐
c. overall economy (availability of work)	☐	☐	☐	☐	☐
d. Availability of labor	☐	☐	☐	☐	☐
e. Governmental Requirements	☐	☐	☐	☐	☐
Site Risk Factors:					
a. Unknown geological conditions.	☐	☐	☐	☐	☐
b. Weather conditions.	☐	☐	☐	☐	☐
c. Location.	☐	☐	☐	☐	☐
Other Factors:	☐	☐	☐	☐	☐

4.4 Population and sample size determination

The population of this study is restricted to include building-contracting companies in the eastern province in Saudi Arabia. According to the Ministry of Municipality and Rural Affairs (MOMRA 2015), there are 93 building contractors classified as grade 1, 2, and 3 in the eastern province.

Respondents from targeted companies are expected to provide financial information about at least one project they are involved in pricing. The projects' type is restricted to large buildings with budget of 25 million riyals or more. This restriction is to insure integrity among projects and to avoid distinctive projects that require special equipment or material. In addition, projects that delivered through Design-Bid-Build are only considered in this study.

Considering the previous restrictions, the representative sample size of the study was calculated using the following formula. (Kish, 1995)

$$n_0 = \frac{pq}{SEM^2}$$

$$n = \frac{n_0}{1 + \frac{n_0}{N}}$$

Where:

(n_0) The first estimated sample size.

(p) The proportion of characteristics measured in the population. It is expressed by, decimal equals to 0.5, which reflects that the maximum sample size is 50% of the population.

(q) (1- p) which is 0.5.

(SEM) The maximum allowed standard error. In this study, it is considered ±10%.

(n) The final estimated sample size.

(N) The targeted population size.

Using Kish equation, n_0 equals to 25 responses from the inter population. The final estimated sample size is calculated by substituting the n_0 in the second equation. For population of 93 contracting companies the final size will be as follows:

$$n = \frac{n_0}{1 + \frac{n_0}{N}} = \frac{25}{1 + \frac{25}{93}} = 19.70 \cong 20\, responses$$

The final sample size is 20 responses which means that the minimum response rate is (19.7/93) * 100 = 21.18 %.

4.5 Data collection final questionnaire

The questionnaire was distributed to contractors through interviews and electronically by email. Using Google forms, respondents were able to fill and submit the questionnaire online. The study targeted key personnel in the contracting companies who has the experience and the knowledge in bid pricing, to provide accurate data.

CHAPTER 5

Data Analysis and Results

Questionnaires were collected from respondents through interviews and online. The study targeted key personnel from contractors side who are involved in the decision making process of bid pricing. The respondents were asked to fill the three parts of the questionnaire, which they are, general information, project information, project condition evaluation. The number of responses was 29 questionnaire. Five of them were rejected due to missing information and incomplete data or because of the low experience of respondents. The remaining 21 valid questionnaires were entered the analysis. Three questionnaires, randomly chosen, were left for validation.

Data from collected questionnaires are categorized into three sections. In the first one, the study provides discussion of the data related to general information provided by the respondents. This information includes years of experience, level of education, and job title of the respondents besides the company grade in MOMRA and the company experience.

The second section discusses the data related to the projects under study. Different statistical measures will be reported such as frequency, mean, and standard deviation.

In the third section, the development of the linear regression model will be presented. The development of the model includes study the correlation between the contingency and other variables. In the next step, backward regression will be applied to determine the main factors affecting the contingency percentage. Finally, the study will provide discussion of the results.

5.1 Part One: General Information

This part provides descriptive statistical analysis for the data submitted by respondent in the first section of the questionnaire.

5.1.1 Level of Education of respondents

Table 2 shows the number of respondents per education level. All respondents are having bachelor's degree or higher. This is because all the targeted contractors are classified contractors. Respondents with lower education levels, less than bachelor degree, may find difficulties understanding some terms in the questionnaire. So the study avoided lower education levels to participate.

Table 2 Respondents' Level of Education

Level of Education of respondents	Frequency	Percent
Bachelor's degree	16	76%
Master's degree	5	24%
Total	21	100%

5.1.2 Job titles of respondents

Table 3 shows the respondents’ job titles. It is noticed that nearly half of the respondents are working as general managers. Usually, top management are involved in the financial details of biding and pricing. In most cases, field staff and execution teams may not be involved in the details of the pricing. Top managers were the main target of the study, who they are responsible for making the decision of contingency.

Table 3 Job Titles of Respondents

Job title of respondents	Frequency	Percent
Project Engineer	5	24%
Project Manager	2	10%
Senior Project Manager	4	19%
Executive Manager	1	5%
General Manager	9	43%
Total	21	100%

5.1.3 Years of experience of respondents

Table 4 shows the number of respondents in respect with years of experience. The dominant percentage of respondents are having 15 years of experience or more. The participation of more experienced people indicates more reliability of the results. Most of the respondents gain their experience in Saudi Arabia, so that they can provide valuable information about the construction market in the country.

Table 4 Respondents' Years of Experience

Respondents Experience (Years)	Frequency	Percent
5 – 10 years	4	19%
10 – 15 years	4	19%
More than 15 years	13	62%
Total	21	100%

5.1.4 Years of experience of the company

Years of experience of the company indicates that the company had survived in the construction market. The lowest years of experience was 7 years, which indicates that the sample understudy are having great experience in the field. Contracting companies that can survive in this industry, corporates effective techniques and tools to achieve profit and stay competitive. With time, companies build their own structure of decision-making process although they still rely on expert judgments and old experiences. This study will investigate how these companies utilize contingency to deal with risks and uncertainties. Table 5 shows the number of companies per years of experience.

Table 5 Companies Years of Experience

Company Experience (Years)	Frequency	Percent
7 – 15 years	8	38%
15 – 35 years	8	38%
More than 35 years	5	24%
Total	21	100%

5.1.5 Company grade in (MOMRA)

According to the contractors’ classification law in Saudi Arabia, contractors are classified into five grades. The classification is based on specific financial and technical limits. In this study only contractors with grades one, two, and three are allowed to participate.

Table 6 Companies Grade According to MOMRA.

Company Grade	Frequency	Percent
1	11	52%
2	2	10%
3	8	38%
Total	21	100%

5.2 Part Two: Project Information

In the second section of the questionnaire, respondents were asked to provide financial data about one of the projects he was involved in pricing. The required data included the amount of the performance bond, the amount of advance payment, and Maximum penalty amount for liquidated damages. To ensure data consistency, respondents were asked to provide this information as percentage from the total contract value. These parameters are in the focus of the contractor especially during bidding stage.

This study considered these parameters as variables that may affect contingency decision. In the regression model development, these variables were analyzed to study their correlation with the dependent variable, which is the contingency amount.

Table 7 Frequency and percent of projects' performance bod amount

Performance bond (% of contract value)	Frequency	Percent
0	3	14%
5	10	48%
10	8	38%
Total	21	100%

Table 8 Frequency and percent of projects' advanced payment amount

Advance payment amount (% of contract value)	Frequency	Percent
0 – 10 %	6	29%
10– 15 %	10	48%
more than 15 %	5	24%
Total	21	100

Table 9 Frequency of liquidated damages amount

Maximum penalty amount for liquidated damages (% of contract value)	Frequency	Percent
0 – 3 %	6	29%
3– 5 %	2	10%
5– 10 %	13	62%
Total	21	100%

5.3 Part Three: Model Development

This section explains a quantitative methodology for determination of the effect of risk and uncertainties on contingency percentage in bidding. This methodology is based on correlation and regression analysis. The proposed model would not only set the foundations for predicting the contingency decision but would also determine the impact of certain risks factors for large building construction projects.

Factors entered the analyses could be group as company and project factors. Company factors includes company grade and company experience. Project factors consists of variables related to financial information about the project such as the amount of the performance bond, the amount of advance payment, and maximum penalty amount for liquidated damages. Furthermore, the project factors included variables related to the evaluation of the project conditions.

5.3.1 Correlation Analysis

Correlation analysis was used to determine the linear relation between contingency and risk factors (Ergin 2005). Variables with linear relation will be included in the initial regression model. Using Pearson correlation coefficient the correlation analysis results show that there were linear relation between contingency and 10 risk factors. The analysis was based on a significance level of $\alpha = 0.10$. Table 10 shows the results of the correlation analysis for all factors.

Table 10 Correlation analysis results

Criteria	Factor Number	Factor Description	Significance level	× = $P < 0.1$ √ = $P > 0.1$
Company	P1	COMPANY GRADE	0.380	×
	P2	COMPANY EXPERIENCE	0.783	×
Contract	P3	Project size	0.217	×
	P4	Contract type	0.248	×
	P5	Performance bond amount	0.200	×
	P6	Advance payment amount	0.670	×
	P7	Penalty for liquidated damages	0.210	×
	P8	CONTINGENCY AMOUNT	Dependent	×
General	P9	Adequacy of schedule requirements	0.001	√
	P10	Adequacy of quality requirements	0.240	×
	P11	Safety and environ. requirements	0.002	√
	P12	Type of equipment required	0.270	×
	P13	material required	0.200	×
	P14	Owner	0.660	×
Design	P15	Quality of drawings	0.710	×
	P16	Designer	0.690	×
	P17	Design complexity	0.110	×
	P18	Owner special requirement	0.950	×
Contractor	P19	Availability of required cash	0.132	×
	P20	Uncertainty in cost estimate	0.920	×
	P21	Similar project experience	0.206	×
	P22	Confidence in work force	0.001	√
	P23	Availability of qualified staff	0.310	×
	P24	Need for work	0.113	×
	P25	Past profit in similar jobs	0.200	×
	P26	Current workload.	0.880	×
	P27	Reliability of subcontractors	0.010	√
	P28	Portion subcontracted to others	0.006	×
Bidding	P29	Competition	0.003	√
	P30	Time allowed for submitting the bids	0.260	×
	P31	Required bond capacity	0.740	×
	P32	Bidding document price	0.910	×
	P33	Prequalification Requirements	0.730	×
Economy	P34	Risk involved in investment	0.002	√
	P35	Availability of equipment	0.020	√
	P36	Overall economy	0.011	√
	P37	Availability of labor	0.001	√
	P38	Availability of material?	0.144	×
	P39	Governmental Requirements	0.660	×
Site	P40	Unknown geological conditions.	0.800	×
	P41	Weather conditions.	0.001	√
	P42	Location.	0.220	×

Table 11 *P* value of the factor correlated with contingency

NO.	Name	Description	*P*
1.	P9	Adequacy of schedule requirements	0.001
2.	P11	Adequacy of safety and environmental requirements	0.002
3.	P22	Confidence in work force	0.001
4.	P27	Reliability of subcontractors	0.002
5.	P29	Competition	0.010
6.	P34	Risk involved in investment	0.002
7.	P35	Availability of equipment	0.020
8.	P36	Overall economy (availability of work)	0.011
9.	P37	Availability of labor	0.001
10.	P41	Weather conditions.	0.001

5.3.2 Regression Model

A linear regression model was developed in order to quantify the impact of the risk factors on contingency. The model's development began by using the 10 factors which were indicated to have a linear relationship with the contingency percentage. The factors were included as independent variables. In the second stage, the backward stepwise regression technique was used to eliminate factors that did not contribute to the model. The P values of the factors were used to determine the factors to be removed. The elimination process was performed in steps; in each step the factor corresponding to the largest P value was eliminated. This process was repeated until all remaining factors had P values of 0.1 or less. Table 12 shows that factor P11, corresponding to the highest P value, was eliminated from the first iteration. In the next steps, factors P37, P29, P27, P41, and P35 were removed respectively. The final regression model included the factors P36, P34, P22, and P9. Table 13 shows the coefficients corresponding to the factors of the final regression model.

Table 12 Elimination of factors

Model	Variables Entered	Variables Removed	Method
1	P41, P35, P27, P36, P34, P22, P11, P9, P29, P37[a]	.	Enter
2	.	P11	0.905
3	.	P37	0.848
4	.	P29	0.856
5	.	P27	0.375
6	.	P41	0.380
7	.	P35	0.120

Dependent Variable: P8

The final regression model had a coefficient of determination (R^2) equals to .935. This is mean that the model can explain 93.5% of the variation in contingency percentage. The following equation shows the final form of the model.

$$\boldsymbol{Contingency} = -\mathbf{0.602} + \mathbf{1.710}\ (\mathbf{P9}) + \mathbf{1.952}\ (\mathbf{P22}) + \mathbf{1.040}\ (\mathbf{P34}) - \mathbf{2.003}\ (\mathbf{P36})$$

Where,

P9: Adequacy of schedule requirements; best = 1, and worse = 5

P22: Confidence in work force; best = 1, and worse = 5

P34: Risk involved in investment; best = 1, and worse = 5

P36: Overall economy (Availability of work); best = 1, and worse = 5

Table 13 coefficients corresponding to the factors of the regression models						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.010	3.830		.002	.998
	P9	2.041	.609	.437	3.350	.007
	P11	.074	.605	.020	.123	.905
	P22	1.894	.666	.385	2.845	.017
	P27	-.473	.615	-.094	-.770	.459
	P29	-.265	1.009	-.049	-.262	.798
	P34	1.085	.741	.200	1.465	.174
	P35	-.556	.785	-.110	-.709	.495
	P36	-1.704	.847	-.306	-2.012	.072
	P37	.173	1.144	.029	.151	.883
	P41	.258	.676	.046	.383	.710
2	(Constant)	-.148	3.443		-.043	.966
	P9	2.023	.565	.434	3.584	.004
	P22	1.894	.635	.385	2.982	.012
	P27	-.454	.568	-.090	-.800	.441
	P29	-.182	.721	-.034	-.253	.805
	P34	1.112	.675	.205	1.647	.128
	P35	-.499	.606	-.099	-.825	.427
	P36	-1.789	.460	-.321	-3.889	.003
	P37	.208	1.058	.035	.196	.848
	P41	.269	.639	.048	.422	.681
3	(Constant)	-.281	3.238		-.087	.932
	P9	2.029	.541	.435	3.752	.003
	P22	1.973	.474	.401	4.161	.001
	P27	-.387	.433	-.076	-.893	.390
	P29	-.111	.596	-.020	-.186	.856
	P34	1.189	.530	.219	2.241	.045
	P35	-.580	.426	-.115	-1.361	.199
	P36	-1.828	.398	-.328	-4.589	.001
	P41	.341	.503	.061	.678	.510
4	(Constant)	-.749	1.952		-.384	.707
	P9	1.985	.467	.425	4.250	.001
	P22	1.980	.455	.403	4.355	.001
	P27	-.359	.390	-.071	-.918	.375
	P34	1.241	.432	.229	2.870	.013
	P35	-.569	.406	-.113	-1.401	.185
	P36	-1.862	.342	-.334	-5.442	.000

	P41	.388	.419	.069	.927	.371
5	(Constant)	-1.346	1.830		-.736	.474
	P9	1.780	.408	.381	4.360	.001
	P22	1.900	.444	.387	4.282	.001
	P34	1.280	.428	.236	2.992	.010
	P35	-.526	.401	-.104	-1.312	.211
	P36	-1.875	.340	-.336	-5.515	.000
	P41	.377	.416	.067	.906	.380
6	(Constant)	-.334	1.441		-.232	.820
	P9	1.790	.406	.384	4.411	.001
	P22	2.059	.405	.419	5.084	.000
	P34	1.378	.411	.254	3.350	.004
	P35	-.630	.382	-.125	-1.647	.120
	P36	-1.990	.313	-.357	-6.348	.000
7	(Constant)	-.602	1.506		-.400	.695
	P9	1.710	.424	.366	4.034	.001
	P22	1.952	.421	.397	4.640	.000
	P34	1.040	.375	.192	2.772	.014
	P36	-2.003	.330	-.359	-6.077	.000

5.3.3 Model Validation

The model validation was performed by substituting the factors' rating of projects with minimum and maximum contingency amounts separately. The minimum contingency amount was 0% and it was used with project that has risk factors rated as the following:

P9:	Adequacy of schedule requirements	= 2
P22:	Confidence in work force	= 2
P34:	Risk involved in investment	= 1
P36:	Overall economy (Availability of work)	= 4

$$Contingency = -0.602 + 1.710\ (\mathrm{P9}) + 1.952\ (\mathrm{P22}) + 1.040\ (\mathrm{P34}) - 2.003\ (\mathrm{P36})$$

$$Contingency = -0.602 + 1.710\ (2) + 1.952\ (2) + 1.040\ (1) - 2.003\ (4)$$

$$Contingency = -0.25\%$$

The contingency amount as estimated by the model was -0.25%, which was very close to the actual amount used for this project. The model may estimate negative contingency under more favorable circumstances.

The maximum contingency amount reported by respondents was 20% with project that has risk factors rated as the following:

P9:	Adequacy of schedule requirements	= 5
P22:	Confidence in work force	= 5
P34:	Risk involved in investment	= 4
P36:	Overall economy (Availability of work)	= 2

$$Contingency = -\ 0.602 +\ 1.710\ (\mathrm{P9}) + 1.952\ (\mathrm{P22}) + 1.040\ (\mathrm{P34}) -\ 2.003\ (\mathrm{P36})$$

$$Contingency = -\ 0.602 +\ 1.710\ (5) + 1.952\ (5) + 1.040\ (4) -\ 2.003\ (2)$$

$$Contingency = -\ 17.86\ \%$$

The contingency amount as estimated by the model was 17.86%, which was close to the actual amount used for this project.

On the other hand, Table 14 shows that R^2 for the final model is 93.5%, which indicates that the final model is able to predict 93.5% of the variation in contingency.

Table 14 Summary of the developed models

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.980[a]	.961	.922	1.40219
2	.980[b]	.961	.929	1.33795
3	.980[c]	.961	.935	1.28323
4	.980[d]	.961	.940	1.23466
5	.979[e]	.958	.940	1.22774
6	.978[f]	.956	.941	1.22039
7	.974[g]	.948	.935	1.28406

a. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P11, P9, P29, P37
b. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9, P29, P37
c. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9, P29
d. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9
e. Predictors: (Constant), P41, P35, P36, P34, P22, P9
f. Predictors: (Constant), P35, P36, P34, P22, P9
g. Predictors: (Constant), P36, P34, P22, P9

5.3.4 Impact of Factors

The impact of the risk factors on the developed model were examined using a sensitivity analysis technique, where one factor was varied between the maximum and minimum, while other factors were set as constants. In the first step, the value of P9 was varied from one to five, while factors P22, P34, and P36 were set at their mean, which was three. The absolute difference in contingency was then reported. For factor P9 the contingency amount corresponding to the minimum value of P9 was 4.075%, while the maximum was 10.915%. In this case the absolute difference in contingency was equal to 6.8%, as shown in the following figure. This process was repeated to determine the impacts of P22, P43, and P36.

The results are illustrated in Figure 2, which shows that factor P34 (the risk involved in the investment) had the lowest financial impact. It also implies that P22 (confidence in the work force) and P36 (the overall economic situation) had almost the same impact, while P9 (the adequacy of schedule requirements) had a moderate impact. In conclusion, the model shows that the financial implications of the trust in the work force are similar to the overall economic implications. On the other hand, the risk involved in investment had less impact, while the schedule requirements had the lowest impact.

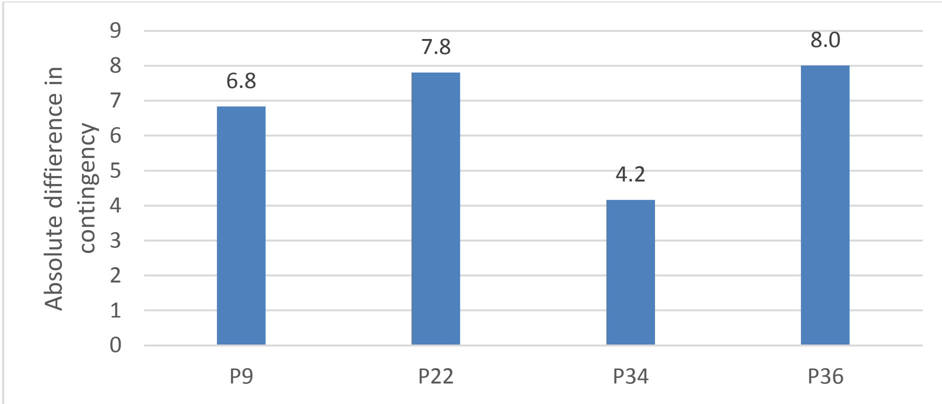

Figure 2 Risk factors impact analysis

5.4 Discussion and conclusion

This research proposed a quantitative methodology using correlation and linear regression techniques to study the relationship between risk factors and the contingency amount used by contractors. Correlation analysis was used to determine factors having linear relations with contingency. Linear regression was used to quantify the impact of the risk factors on contingency. The model might be improved using nonlinear regression analysis; however, the application of nonlinear regression would be more complicated. In addition, the results of the model validation techniques showed the adequacy of the model.

Results indicated that the variation in contingency levels of building projects in Saudi Arabia could be related to four factors. The first factor is the overall economy and the availability of other opportunities, which has the greatest impact on the contingency decision. This factor indicates that contractors use a minimum contingency when the economic situation is in its worst case. Contractors follow this strategy are trying to stay in the market and survive. Larger contingency levels would be used in case the economic situation is in the best condition. In other words, contractors tend to be more cautious when they have more job opportunities on the horizon.

The second factor is the confidence in the work force, which had a similar impact on contingency as the first factor. The model indicates that the work force is the focus of contractors during bidding. Contractors would use lower contingency levels when the reliability of labor to do the job is high. Unskilled labor could produce defective work or cause a delay for the project. Contractors would be held responsible for the delay, and might be subjected to either redoing or repairing these defects at their expense. Likewise, contractors consider acquiring skilled labor to be challenging. The large impact of labor on the contingency level can be related to the special characteristics of the construction industry in Saudi Arabia.

The third factor is the adequacy of schedule requirements, which had a lower impact than the first two. The schedule requirements includes the start date, finish date, and time allotted to finish the project. Contractors may be required to increase their resources in order to achieve the specified schedule requirements. Acquiring more resources could be achieved by hiring an external work force and equipment, or by involving new subcontractors.

The fourth factor is risk involved in the investment, which had the lowest impact on the contingency level. Contractors use high levels of contingency when the risk of investment is high. In contrast, contractors use a lower contingency when they expect to realize more profit from the project.

The methodology presented in this study allows for the identification of the factors affecting the contingency level. Moreover, the developed regression model could be implemented to quantify the financial impact of risk factors and uncertainties during the bidding stage. The developed regression model could be used as a powerful tool to determine contingency in large building construction projects in Saudi Arabia.

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Appendix

Final Questionnaire Sample

FACTORS AFFECTING CONTINGENCY AMOUNT IN CONSTRUCTION PROJECTS

CONTRACTOR'S PERSPECTIVE

PRESENTED BY: SHADI ABO ABDO
KING FAHD UNVERSITY FOR PETRUIUM AND MENIRALS
DHAHRAN, 31261, KINGDOM OF SAUDI ARABIA

PURPOSE

- The aim of this questionnaire is to study factors affecting contingency in construction.
- الهدف من هذا الاستبيان هو دراسة العوامل التي تؤثر في تقدير مبلغ الطوارئ في المشاريع الانشائية.

- This study is conducted as a part of master degree thesis at KFUPM University.
- يتم إجراء هذه الدراسة كجزء من أطروحة ماجستير في جامعة الملك فهد للبترول والمعادن.

- All information provided will be used only for academic purposes.
- جميع المعلومات المقدمة ستستخدم للأغراض أكاديمية فقط.

- You are expected be able to provide information regarding <u>bid pricing of projects in your company</u>.
- يجب أن تكون قادرا على تقديم معلومات بشأن تسعير العطاءات للمشاريع الهندسية في الشركة التي تعمل فيها.

- Time estimated to fill the questionnaire is 15 min.
- الوقت المقدر لملء الاستبيان هو 15 دقيقة.

- Thank you for your cooperation.
- شكراً لتعاونكم.

Personal Information

NAME: الاسم:	
EMAIL/PHONE : الهاتف/البريد الالكتروني:	
EDUCATION: التعليم:	(___) Technical/ training (___) Associate degree (___) Bachelor's degree (___) Professional degree (___) Master's degree (___) Doctorate degree (___) التدريب التقني/المهني (___) درجة الدبلوم (___) درجة البكالوريوس (___) درجة المهنية (___) الدرجة الماجستير (___) الدكتوراه
YEARS OF EXPERIENCE: سنوات الخبرة:	☐ < 5 ☐ 5 – 10 ☐ 10 – 15 ☐ > 15
POSTION (OPTIONAL): المنصب (اختياري):	

COMPANY INFORMATION

COMPANY GRADE (MUMRA): تصنيف الشركة:	
COMPANY EXPERIENCE (YEARS): سنوات الخبرة (سنة):	

PROJECT INFORMATION

<table>
<tr><td colspan="2">ANSWER THE FOLLOWING, CONSIDERING ONE OF THE BUILDING PROJECTS YOU ARE INVOLVED IN PRICING:

اجب عن التالي اخذاً في الاعتبار أحد المشاريع التي شاركت في تسعيرها:</td></tr>
<tr><td>Project size (SR): حجم المشروع (ريال):</td><td></td></tr>
<tr><td>Contract type: نوع العقد:</td><td>☐ Unit price ☐ Lump Sum
☐ Cost plus ☐ Other</td></tr>
<tr><td>Project delivery method: طريقة تسليم المشروع:</td><td>☐ Design-bid-build ☐ Design-build
☐ Other ( )</td></tr>
<tr><td>Performance bond amount (% of contract value):
قيمة ضمان حسن التنفيذ (٪ من قيمة العقد):</td><td></td></tr>
<tr><td>Advance payment amount (% of contract value):
قيمة الدفعة المقدمة (٪ من قيمة العقد):</td><td></td></tr>
<tr><td>Maximum penalty amount for liquidated damages (% of contract value):
الحد الأقصى لعقوبة الأضرار الناجمة عن التأخير (٪ من قيمة العقد):</td><td></td></tr>
<tr><td>CONTINGENCY AMOUNT (% of contract value):
مبلغ الطوارئ (٪ من قيمة العقد):</td><td></td></tr>
</table>

PROJECT CONDITIONS EVALUATION:

Evaluate the following project conditions at the time of pricing the above-mentioned project.

قم بتقييم حالة المشروع من الجوانب التالية وذلك في وقت تسعير العطاء الخاص بالمشروع السابق.

	1= Best Condition				5 = Worst Condition
	1	2	3	4	5
General Project Risk Factors: العوامل العامة:					
a. How do you evaluate the adequacy of Schedule requirements? كيف تقييم متطلبات الجدولة الزمنية للمشروع؟	☐	☐	☐	☐	☐
b. How do you evaluate the quality requirements? كيف تقييم متطلبات الجودة الخاصة بالمشروع؟	☐	☐	☐	☐	☐
c. How do you evaluate safety and environmental requirements? كيف تقييم متطلبات السلامة والمتطلبات البيئية؟	☐	☐	☐	☐	☐
d. How do you evaluate the type of equipment required? ما هو تقييمك لنوع الاليات المطلوبة لإنجاز المشروع؟	☐	☐	☐	☐	☐
e. How do you evaluate the type of material required? ما هو تقييمك لنوع المواد المطلوبة لإنجاز المشروع؟	☐	☐	☐	☐	☐
f. How do you evaluate the owner reputation? ما هو تقييمك لسمعة المالك؟	☐	☐	☐	☐	☐
Project documents: وثائق المشروع:					
a. What is your evaluation of the quality of drawings? ما هو تقييمك لجودة المخططات؟	☐	☐	☐	☐	☐
b. What is your evolution of the designer/consultant? ما هو تقييمك ل(المصمم/الاستشاري) للمشروع؟	☐	☐	☐	☐	☐
c. What is your evolution of the design complexity? ما هو تقييمك لتعقيد التصميم؟	☐	☐	☐	☐	☐
d. What is your evolution of the owner special requirement? ما هو تقييمك للمتطلبات خاصة بالمالك؟	☐	☐	☐	☐	☐

	1= Best Condition				5 = Worst Condition
	1	2	3	4	5
Company Risk Factors: عوامل خاصة بالشركة:					
a. How do you evaluate the availability of required cash? كيف تقييم توفر السيولة المالية في شركتك؟	☐	☐	☐	☐	☐
b. How do you evaluate the certainty in your cost estimate? كيف تقييم الدقة في تقدير التكلفة؟	☐	☐	☐	☐	☐
c. How do you evaluate your company experience in similar project? كيف تقييم خبرة شركتك في مشاريع مماثلة؟	☐	☐	☐	☐	☐
d. How do you evaluate the confidence in work force? كيف تقييم الثقة في العمالة المتوفرة؟	☐	☐	☐	☐	☐
e. How do you evaluate the availability of qualified staff? كيف تقييم توافر الموظفين المؤهلين؟	☐	☐	☐	☐	☐
f. How do you evaluate your company need for work? كيف تقييم حاجة شركتك للعمل؟	☐	☐	☐	☐	☐
g. What is your evaluation of the past profit in similar jobs? كيف تقييم الربح السابق في المشاريع مماثلة؟	☐	☐	☐	☐	☐
h. What is your evaluation of your company current workload? كيف تقييم عبء العمل الحالي في شركتك؟	☐	☐	☐	☐	☐
j. How do you evaluate the reliability of subcontractors? كيف تقييم الموثوقية في مقاولي الباطن؟	☐	☐	☐	☐	☐
k. How do you evaluate the portion subcontracted to others? كيف تقييم نسبة العمل الموكل لمقاولي الباطن؟	☐	☐	☐	☐	☐
Bidding Situation: حالة تقديم العطاءات					
a. What is your evaluation of the competition on the project? كيف تقييم المنافسة على المشروع؟	☐	☐	☐	☐	☐
b. How do you evaluate the time allowed for submitting bids? كيف تقييم الوقت المسموح به لتقديم العطاءات؟	☐	☐	☐	☐	☐

	1= Best Condition				5 = Worst Condition
	1	2	3	4	5
c. How do you evaluate the required bond capacity? كيف تقييم قيمة الضمان البنكي؟	☐	☐	☐	☐	☐
d. How do you evaluate the price of bidding document? كيف تقييم سعر وثائق العطاء؟	☐	☐	☐	☐	☐
e. How do you evaluate the prequalification requirements? كيف تقييم المؤهلات المطلوبة لدخول العطاء؟	☐	☐	☐	☐	☐
Economic Situation: الوضع الاقتصادى:					
a. What is your evaluation of the risk involved in investment? ما هو تقييمك لمخاطر المشاركة في الاستثمار؟	☐	☐	☐	☐	☐
b. What is your evaluation of the availability of equipment? كيف تقييم توافر المعدات اللازمة؟	☐	☐	☐	☐	☐
c. How do you evaluate the overall economy (availability of work)? ما هو تقييمك للوضع الاقتصادي الكلي (توافر العمل)؟	☐	☐	☐	☐	☐
d. What is your evaluation of the availability of required labor? ما هو تقييمك لتوافر العمالة المطلوبة لإنجاز المشروع؟	☐	☐	☐	☐	☐
e. What is your evaluation of the availability of material? ما هو تقييمك لتوافر المواد اللازمة لإنجاز المشروع؟	☐	☐	☐	☐	☐
f. How do you evaluate the governmental requirements? ما هو تقييمك للمتطلبات الحكومية؟	☐	☐	☐	☐	☐
Site Risk Factors: عوامل الخطر في الموقع:					
a. How do you evaluate the risk of unknown geological conditions? ما هو تقييمك لخطر الظروف الجيولوجية الغير معروف؟	☐	☐	☐	☐	☐
b. What is your evaluation of the weather conditions? ما هو تقييمك أحوال الطقس؟	☐	☐	☐	☐	☐
c. What is your evaluation of the project location? ما هو تقييمك لمكان المشروع؟	☐	☐	☐	☐	☐
Other Factors: أخرى:					
. . . .	☐	☐	☐	☐	☐
. . . .	☐	☐	☐	☐	☐

Regression Analysis log SPSS

```
GET
  FILE='C:\Users\Shadi\Dropbox\CEM\Thesis_2\ANALYSIS\SHD_KHALED_FINAL\Contingen
cy-DATA - Copy.sav'.
DATASET NAME DataSet0 WINDOW=FRONT.
REGRESSION
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS R ANOVA
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT P8

  /METHOD=BACKWARD P9 P11 P22 P27 P29 P34 P35 P36 P37 P41.
```

Regression

Notes

Output Created		01-Dec-2015 09:20:01
Comments		
Input	Data	C:\Users\Shadi\Dropbox\CEM\Thesis_2\ANALYSIS\SHD_KHALED_FINAL\Contingency-DATA - Copy.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	21
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on cases with no missing values for any variable used.
Syntax		REGRESSION /MISSING LISTWISE /STATISTICS COEFF OUTS R ANOVA /CRITERIA=PIN(.05) POUT(.10) /NOORIGIN /DEPENDENT P8 /METHOD=BACKWARD P9 P11 P22 P27 P29 P34 P35 P36 P37 P41.
Resources	Processor Time	00:00:00.047

	Elapsed Time	00:00:00.051
	Memory Required	6292 bytes
	Additional Memory Required for Residual Plots	0 bytes

[DataSet1] C:\Users\Shadi\Dropbox\CEM\Thesis_2\ANALYSIS\SHD_KHALED_FINAL\Contingency-DATA - Copy.sav

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	P41, P35, P27, P36, P34, P22, P11, P9, P29, P37[a]	.	Enter
2	.	P11	Backward (criterion: Probability of F-to-remove >= .100).
3	.	P37	Backward (criterion: Probability of F-to-remove >= .100).
4	.	P29	Backward (criterion: Probability of F-to-remove >= .100).
5	.	P27	Backward (criterion: Probability of F-to-remove >= .100).

6		. P41	Backward (criterion: Probability of F-to-remove >= .100).
7		. P35	Backward (criterion: Probability of F-to-remove >= .100).

a. All requested variables entered.

b. Dependent Variable: P8

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.980[a]	.961	.922	1.40219
2	.980[b]	.961	.929	1.33795
3	.980[c]	.961	.935	1.28323
4	.980[d]	.961	.940	1.23466
5	.979[e]	.958	.940	1.22774
6	.978[f]	.956	.941	1.22039
7	.974[g]	.948	.935	1.28406

a. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P11, P9, P29, P37

b. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9, P29, P37

c. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9, P29

d. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9

e. Predictors: (Constant), P41, P35, P36, P34, P22, P9

f. Predictors: (Constant), P35, P36, P34, P22, P9

g. Predictors: (Constant), P36, P34, P22, P9

ANOVA[h]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	486.577	10	48.658	24.748	.000[a]
	Residual	19.662	10	1.966		
	Total	506.238	20			
2	Regression	486.547	9	54.061	30.200	.000[b]
	Residual	19.691	11	1.790		
	Total	506.238	20			
3	Regression	486.478	8	60.810	36.929	.000[c]
	Residual	19.760	12	1.647		
	Total	506.238	20			
4	Regression	486.421	7	69.489	45.585	.000[d]
	Residual	19.817	13	1.524		
	Total	506.238	20			
5	Regression	485.135	6	80.856	53.642	.000[e]
	Residual	21.103	14	1.507		
	Total	506.238	20			
6	Regression	483.898	5	96.780	64.981	.000[f]
	Residual	22.340	15	1.489		
	Total	506.238	20			
7	Regression	479.857	4	119.964	72.759	.000[g]
	Residual	26.381	16	1.649		
	Total	506.238	20			

a. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P11, P9, P29, P37

b. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9, P29, P37

c. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9, P29

d. Predictors: (Constant), P41, P35, P27, P36, P34, P22, P9

e. Predictors: (Constant), P41, P35, P36, P34, P22, P9

f. Predictors: (Constant), P35, P36, P34, P22, P9

g. Predictors: (Constant), P36, P34, P22, P9

h. Dependent Variable: P8

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.010	3.830		.002	.998
	P9	2.041	.609	.437	3.350	.007
	P11	.074	.605	.020	.123	.905
	P22	1.894	.666	.385	2.845	.017
	P27	-.473	.615	-.094	-.770	.459
	P29	-.265	1.009	-.049	-.262	.798
	P34	1.085	.741	.200	1.465	.174
	P35	-.556	.785	-.110	-.709	.495
	P36	-1.704	.847	-.306	-2.012	.072
	P37	.173	1.144	.029	.151	.883
	P41	.258	.676	.046	.383	.710
2	(Constant)	-.148	3.443		-.043	.966
	P9	2.023	.565	.434	3.584	.004
	P22	1.894	.635	.385	2.982	.012
	P27	-.454	.568	-.090	-.800	.441
	P29	-.182	.721	-.034	-.253	.805
	P34	1.112	.675	.205	1.647	.128
	P35	-.499	.606	-.099	-.825	.427
	P36	-1.789	.460	-.321	-3.889	.003
	P37	.208	1.058	.035	.196	.848
	P41	.269	.639	.048	.422	.681
3	(Constant)	-.281	3.238		-.087	.932
	P9	2.029	.541	.435	3.752	.003
	P22	1.973	.474	.401	4.161	.001
	P27	-.387	.433	-.076	-.893	.390
	P29	-.111	.596	-.020	-.186	.856
	P34	1.189	.530	.219	2.241	.045

	P35	-.580	.426	-.115	-1.361	.199
	P36	-1.828	.398	-.328	-4.589	.001
	P41	.341	.503	.061	.678	.510
4	(Constant)	-.749	1.952		-.384	.707
	P9	1.985	.467	.425	4.250	.001
	P22	1.980	.455	.403	4.355	.001
	P27	-.359	.390	-.071	-.918	.375
	P34	1.241	.432	.229	2.870	.013
	P35	-.569	.406	-.113	-1.401	.185
	P36	-1.862	.342	-.334	-5.442	.000
	P41	.388	.419	.069	.927	.371
5	(Constant)	-1.346	1.830		-.736	.474
	P9	1.780	.408	.381	4.360	.001
	P22	1.900	.444	.387	4.282	.001
	P34	1.280	.428	.236	2.992	.010
	P35	-.526	.401	-.104	-1.312	.211
	P36	-1.875	.340	-.336	-5.515	.000
	P41	.377	.416	.067	.906	.380
6	(Constant)	-.334	1.441		-.232	.820
	P9	1.790	.406	.384	4.411	.001
	P22	2.059	.405	.419	5.084	.000
	P34	1.378	.411	.254	3.350	.004
	P35	-.630	.382	-.125	-1.647	.120
	P36	-1.990	.313	-.357	-6.348	.000
7	(Constant)	-.602	1.506		-.400	.695
	P9	1.710	.424	.366	4.034	.001
	P22	1.952	.421	.397	4.640	.000
	P34	1.040	.375	.192	2.772	.014
	P36	-2.003	.330	-.359	-6.077	.000

a. Dependent Variable: P8

Excluded Variables[g]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
2	P11	.020[a]	.123	.905	.039	.150
3	P11	.026[b]	.173	.865	.052	.160
	P37	.035[b]	.196	.848	.059	.112
4	P11	-.002[c]	-.020	.984	-.006	.368
	P37	.012[c]	.082	.936	.024	.151
	P29	-.020[c]	-.186	.856	-.054	.269
5	P11	-.008[d]	-.085	.933	-.024	.370
	P37	-.043[d]	-.333	.744	-.092	.190
	P29	.014[d]	.137	.893	.038	.307
	P27	-.071[d]	-.918	.375	-.247	.505
6	P11	-.022[e]	-.243	.812	-.065	.383
	P37	-.001[e]	-.010	.992	-.003	.216
	P29	-.027[e]	-.306	.764	-.081	.401
	P27	-.069[e]	-.897	.385	-.233	.505
	P41	.067[e]	.906	.380	.235	.544
7	P11	-.071[f]	-.834	.417	-.211	.455
	P37	.095[f]	1.060	.306	.264	.401
	P29	-.035[f]	-.377	.711	-.097	.402
	P27	-.052[f]	-.640	.532	-.163	.514
	P41	.095[f]	1.304	.212	.319	.592
	P35	-.125[f]	-1.647	.120	-.391	.514

a. Predictors in the Model: (Constant), P41, P35, P27, P36, P34, P22, P9, P29, P37

b. Predictors in the Model: (Constant), P41, P35, P27, P36, P34, P22, P9, P29

c. Predictors in the Model: (Constant), P41, P35, P27, P36, P34, P22, P9

d. Predictors in the Model: (Constant), P41, P35, P36, P34, P22, P9

e. Predictors in the Model: (Constant), P35, P36, P34, P22, P9

f. Predictors in the Model: (Constant), P36, P34, P22, P9

g. Dependent Variable: P8

Vitae

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Academic Background :

- M.Sc. in Construction Engineering and Management from King Fahd University of Petroleum and Minerals, Saudi Arabia, 2013 To 2016.
- B.Sc. in Civil Engineering from Islamic University, Gaza - Palestine, 2006 To 2011, (Graduation Project Name: Signal Coordination of El. Nasser Street).
- High school from El-Karmel Secondary School, Gaza-Palestine, 2005 To 2006, (Average 94.9%)

Training and courses :

- Training course in “Autodesk Revit Structure”, 60 hours, Engosoft Intelligence Academy, KSA, 2016.
- Training course in “Preparing Supervisor Engineer”, 65 hours, Association of Engineers, Gaza, Palestine, 2012.
- Test of English as a Foreign Language (TOEFL), score of 570, 2012.
- Three courses in, “ Feasibility Studies ”, “ Preparation of Business Plans ”, and “Presentation skills”, 33 hours, The

Business and Technology Incubator- BTI, Gaza, Palestine, 2011.

- Training course in " AutoCAD Civil 3D Land Desktop ", 24 hours, Islamic University, Gaza, Palestine, 2011.
- Training course in "Test of English as a Foreign Language (TOEFL)", 40 hours, Islamic University, Gaza, Palestine, 2011.
- Training course in "Damage Assessment and Rehabilitation Facilities", 30 hour, Association of Engineers, Gaza, Palestine, 2010.
- Training course in "STAAD Pro, SAP, SAFE ", 30 hours, Islamic University, Gaza, Palestine, 2009.
- Training course in " AutoCAD2007 ", 30 hours, Islamic University, Gaza, Palestine, 2008.