



Causes of construction reworks and their mitigation strategies

الأسباب المؤدية لإعادة الأعمال بالإنشاءات وطرق تقليل التأخير

by

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of the requirements for the degree of
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Abstract

Projects always having a limited time period and each of them are versatile in concept. With due regards especially construction sector facing a difficulties facing many problems but one of the major is rework. This all is due to limitless requirements and unforeseen circumstances. Therefore this project management dissertation is about digging deep **causes of project reworks** as well as its mitigation ways consisting of literature review which ends up with conceptual model and developed 5 hypothesis which is core of my survey questionnaire. Its factors mainly includes reasons of project works repetitions are poor project managements , un maintained project machinery and less manpower , countries overall surround situations, project design confusions , stakeholder concerns and weak communication plans. On the opposite side reworks mitigation plan consists of better quality assurance/control methods, better condition project machines and efficient staff and professional workers, owner demand oriented, and better communications procedures. These hypothesis conclusions made on SPSS results whose base is professionals reply on questionnaire.

Later 3 **project reworks records** goggled from my professional history , meetings done with management's team about the problems faced due to reworks on projects.3 reworks case studies discussed in tabular form and shown their results in terms of effects of project schedule, project cost, and project quality in graphical representation.

Further going forward hypothesis results and case studies comparison discussed which concluded that literature review, SPSS results and case studies are totally aligned about route causes and further mitigation techniques.

Later writer highlighted strategy **planning approach and reduction of reworks** by performance management techniques, reworks risk considerations and lately dissertation recommended to build an innovative teams on the project which is the only way of reducing the reworks on the projects.

Survey questionnaire prepared considering the literature review on project reworks and its mitigation strategies further considering views of market professionals. SPSS used to analysis the professional feedback and 3 project case studies tabulated after extensive interviews.

Going further comparison done between SPSS analysis and 3 case studies. Lastly highlights done on strategy and building innovative team which reduces project reworks.

This dissertation shown six causes of reworks and five mitigation techniques to reduce the reworks. Main causes of works reputation are poor project management team, less manpower and non-maintained construction machinery, country political situation, Week project documents, stakeholders and communication problems and weak commination between project team. In mitigation techniques consists of best quality control procedures, competent staff and skilled workers, Owner demand focused, reviewing the project documents and controlled communication.

Considering the above objective conceptual model prepared following the questionnaire.

Later these factors will be analyzed to computer the significance and variance of independent factors on depend factors. By reducing the reworks , client feel more comfortable and satisfied, company market value increases ,less wastage of material, reduce waste and time, fatigue and tension will be less among staff , more comfortable and safe work environment can be achieved.

SPSS results on professional feedback re confirmed that above stated causes from literature review prompts the works repetition on the project and stated above mitigation strategies

reduces the reworks dramatically which controls project cost and schedule. Positive variance achieved by seeing regression results, the highest variance noted 28.6 % by implementing by applying global factors. Further R square results show that implementation of QA/QC principles added maximum variance which is 27.9 percent to improve project management which reduces the reworks.

Going further deep in practical life all 3 cases studies reworks caused due to above highlighted discrepancies on the project which really caused project completion over cost and over schedule.

he student has not find opportunity working long time in building industry so no that deep technical details in this desertion about causes of reworks in building construction works and their resolutions .This assignment is only covering infrastructure part of civil works around gulf but mostly in UAE.

This dissertations will guide infrastructure managers to achieve project milestones and key performance indicators by keeping in mind works end results .This dissertations is one among value addition in current project management library. Finally it really a useful guide for managers to keep project on schedule and on track especially at difficult times.

The writer wishes that due to unlimited complications in construction industry manager shall always keep in mind that with in no time project may enter into works repetition stage which would be enough loosing owner trust. So professionals to discover the strategies to complete on schedule and on cost project by reducing projects reworks.

ملخص الدراسة

المشاريع لديها دائما فترة زمنية محدودة ولكل مشروع منها تنوعا في المفهوم. و بالنظر إلى قطاع الإنشاءات وخاصة قطاع البناء الذي يواجهه العديد من ا

لصعوبات و المشاكل الكبرى و منها إعادة تنفيذ الأعمال بالمشروع. كل هذا يرجع إلى المتطلبات الغير محددة و الظروف الغير متوقعة. لذا فإن هذه الدراسة حول إدارة المشروع التي تعنى بالبحث في الأسباب العميقة المؤدية لإعادة الأعمال بالمشروع بالإضافة إلى طرق تقليل التأخير والتي تناقش بالإطار النظري للبحث و تنتهي بنموذج مفاهيمي وتطوير 5 فرضيات والتي تشكل جوهر استبيان المسح الخاص بي. وتتضمن العوامل بشكل رئيسي أسباب تكرار أعمال المشروع، وهي كالتالي إدارة ضعيفة للمشروعات و عدم صيانة معدات المشروع و قلة القوى العاملة والحالة العامة المحيطة بالبلد والإرتباكات المتعلقة بتصميم المشروع و مخاوف المالكين القائمين على المشروع وضعف التخطيط والتنسيق الداخلي على الجانب الآخر، تتكون خطة تقليل التأخير من التالي: أساليب أفضل للإنتاج / مراقبة أفضل للجودة وتحسين أوضاع معدات المشروع وتحسين كفاءة الموظفين والعاملين المهنيين وتحقيق متطلبات المالكين والقائمين على المشروع وتحقيق إجراءات أفضل للتنسيق والاتصال الداخلي. هذه الاستنتاجات التي تم معالجتها ببرنامج SPSS وهو قاعدة المهنيين للتحقق من الاستبيانات.

و من منطلق خبرتي لسجلات إعادة أعمال المشروع التي تم تدقيقها من تاريخي المهني، والاجتماعات التي أجريناها مع فريق الإدارة حول المشاكل التي تواجهها بسبب إعادة الأعمال المشاريع. ثلاثة حالات للدراسة تمت مناقشتها في جدول وعرضت نتائجها من حيث آثارها على الجدول الزمني للمشروع وتكلفة المشروع وجودة المشروع في التمثيل البياني.

وبالمضي قدماً ومواصلة نتائج الفرضية ومقارنة دراسات الحالة التي خلصت المناقشة النظرية للبحث ونتائج SPSS ودراسات الحالة تتماشى تماما مع أسباب المؤدية للتأخير وتقنيات تخفيف تأخير المشروع.

وشدد الكاتب في وقت لاحق على نهج التخطيط الاستراتيجي والحد من إعادة الأعمال بالمشروع من خلال تقنيات إدارة الأداء وبالأخير فإن هذه الدراسة تبين كيفية بناء فريق لديه أفكار مبتكرة بالمشروع وهي الطريقة الوحيدة للحد من إعادة الأعمال بالمشاريع.

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Chapter No 1

1.1 Introduction

In this chapter literature gathered which is about explaining construction sector role in developing countries economy, past literature about problems in construction sector which concludes project reworks are among the major causes. Going further deep literature added about versatility of construction works and many different definitions of project reworks. Later stated that how reworks impacts project manager's performances, project milestones and KPIs addition to pressure from owner and regulatory agencies. Chapter 1 last part states about gaps in discovering the project reworks following dissertation aim, objective, scope and research question which relates to rework causes, mitigation strategies and 3 case studies.

1.2 Back ground

Construction projects are always core of economy in developing countries as well as in developed countries. Each country according to its economy use to spend money on buildings and infrastructure projects (Al-Ahram and Ensley, 2013). During last 10 years majority of projects completed by over schedule as well as over cost and due reason its alarming subject in the industry, After investigations reworks found among the core reasons which causes schedule or project cost overrun (Akintoye et al., 2014).

Many **definitions** have been stated about reworks, among these definitions some are, reworks are said to be deliverables which are one completed at the project but unfortunately its required to be done again which is due to any type of discrepancy that is must to be in cooperated on the project, the cause may be any could be a variation, change in scope, poor works quality and so on (Fayek, et al. 2003). It's finally concluded by industrial professionals the reworks are major cause of delay on projects, although some other definitions where reworks come up as important factor which added days in the project as well as increased its cost (Chan and Kumaraswamy, 1997; Thomas

and Neapolitan, 1994). Going further literature states that deviation from quality always brings reworks (Burati et al. 1992). nonconformance generates reworks ” (Abdul-Rahman, 1995) , again project quality failure originates reworks (Barber et al. 2000). based on different ways of defining in project management books , Love (2002) describes reworks as ‘the way of completion in order to ensure that basic demand are fulfilled by implementing corrections’ (Ashford, 1992) also ‘ performing to improve something by repetition which might be due to nonconformance requirements’(Construction Industry Development Agency, 1995).). Love et al. (2000) states that rework may be think as ‘extra energy utilization of redoing a deliverable or the works that was not handled properly once’. Love et al. (1997) defines the rework after a deep study as there are some parameters which are not being cared for example, staff, project documents, stakeholders etc.

Now going further studies showed that causes of works repetitions and project delays vary from developing countries or developed countries (Shebob et al., 2012). There is no doubt that constructions works are complicated and involve unlimited hazards. Over and above projects use to be different in works , different in cost , different in team members , different in locations , different in environment and additional complications added by complex and long contract documents and lot of human resource requirements (Dadzie et al., 2012; Ahiaga-Dagbui and Smith, 2014).

1.3 Problem

Project manager outputs are deeply affected due to project challenging environment and its versatility on the other side everyone is expecting project on schedule and cost completion sometimes shall have to save cost although unforeseen and uncalculated discrepancies (Enshassi et al., 2003, 2008).

Project key performance indicators and mile stones are directly affected due to reworks which originate due to poor management. On the other side project is only successful when it will be completed according to stakeholder's owner's vision and objectives (Hwang and Leong, 2013). Projects use to be surrounded lot of danger of reworks, many industrial countries conclude that projects demands extra 7 percent to 21 percent extra only due to eruptions of project reworks (Ye et al., 2014). Government as well as private sectors adding lot of extra money due to reworks originated due to many reasons not only at execution stage but during guarantee period and even beyond (Kakitahi et al., 2013). Wanberg et al. (2013) states that if quality documents shall be best implemented its may reduce huge amount of project reworks.

1.4 GAP

Work repetitions are major reason of project schedule disturbance as well as project over budget .Its true it's not easy to control. So after lot of loses due to rework it felt to deeply dig the deep reasons of doing the same work another time. (Akin, 1986; Miller, 1993; Rounce, 1998; Love and Li, 2000) describes 3 major causes of works repetition are project design problems, improper way of works execution, and weak project team.

1.5 Aim

To understand the deep reason which erupts works repetition on projects and comparison of literature with 3 project case studies, therefore expending exposure to accomplish projects by minimizing reworks on projects.

1.6 Objectives

- To explore causes of reworks on construction projects.
- To understand how poor project management team , unskilled manpower and unmaintained machinery , countries political situation , Weak project documents , stakeholders discrepancies and miscommunication makes a ground for works repetition.
- To elaborate and explain the ways like project quality assurance and control, professional and experienced work force, Owner demand focused team, reviewing the project documents, coordinated communications can reduce the project reworks.
- 3 projects reworks case study to understand on ground reasons for eruption of reworks and graphical representation of project conditions.
- General Risks on every project which triggers the reworks.
- |Comparison between SPSS results and case studies later findings and results.
- Strategy planning approach and reduction of reworks by performance management techniques.

1.7 Scope

Works repetition affects project in many ways .This dissertation is only limited to discover the reworks reasons, how to mitigate the reworks in order for smooth project completion. 3 project case studies showing the actual ground reasons of works repetition causes, comparison between literature view and case studies ground reasons. Lastly explained strategy planning approach and performance management techniques which minimizes project reworks.

1.8 Research question

The main concept of reworks to explore reasons of behind works repetitions on projects , how to minimize project reworks and better mitigation .3 case studies to understand the ground actual

reworks erupted in gulf areas especially in UAE .Comparison between reworks erupted in UAE and SPSS results. This project statement is better explained by the below principal line.

2 Chapter 2

Literature Review about Causes & Mitigation of Project Reworks.

2.1 Introduction

In second chapter literature explains in detail about 5 influential factors which originates danger to project reworks which are related to owner, design, contractor, vendor and transport. Probability of project reworks dramatically increases if project is having poor project management, no maintained machinery, poor market dynamics understanding, project documents complications, and supplier and communications issues. In order to counter the limit less challenges project team needs to apply quality control procedures, hiring of professional staff and best machinery, dynamic market strategy, deep restudy of project case and balance communications. Chapter 2 last highlights about literature review references in tabular form following 2 conceptual models which are reworks causes and its mitigation.

2.2 Literature Review

Davis et al. (1989), states that there are some **influential factors** which originates the rework on construction projects. These influential factors are five in numbers. Further illustration may we find in below table.

Reworks related to owner.

Reworks related to design.

Reworks related to contractor.

Reworks related to vendor.

Reworks related to transport.

2.2.1 Reworks related to owner.

There are some reworks which originated from clients actions .Normally these items belongs to weak project experience and unaware of design issues , not knowing the technicalities' involved on projects , less project cost nominated for project deep study , misleading communication with project management team / consultants and discrepancies in managing contract documents. Each factor stated above drags the project from on schedule and on cost project completion. Any of above deliverable is a reason for project deviations, project errors and reworks (Daly and Crawhaw, 1973). Literature also states that best way to tackle the owner issues is to emphasis on better communication approach (walker, 1994).

About reworks (British dictionary) states as to enrich or develop the excellence of the executed work for the purpose of matching with the owner demand or to compete the local or international market either improving its value (Hornby, 2015).Reworks can be defined as completing any type of assigned task by redoing some of its action repetition (Love et al., 2015) states that project reworks are the outcomes of unintended or rapid/swift accomplishment of deliverables by even not caring /bothering the project quality.

2.2.2 Reworks related to design

Whenever discrepancies found in project papers, then it's the design consultant to provide revised design updates and alarm construction team about any type of risk of variation (CII , 1990).In case of any type of miscommunication or failure results in rework whenever stakeholders decides their own /otherwise (Josephson and Hammarlund 1999). The literature written by (Love & Li, 2000) states that main rework reason come up due to lake of cooperation/coordination as well as weak team's interaction and stopping project knowledge flow. On the other side gaps noted between project engineers and architects always pave the way for errors in drawings and scale mistakes which discovered only when it's noted the reworks happened (Love et al. 2012).

2.2.3 Reworks related to contractor.

The professionalism of contractor is mandatory to emphasize best cooperation of all other stakeholders and junior staff who are on the same track and will be part of accomplishing the projects (Chan 1998; Walker 1994). The technique will help in better management of stakeholders and team members .As per meeting took place on business happened on 1982, it resulted that incapability of engineers to implemented project schedule properly , activates breakdown discrepancies concludes errors which only ends with reworks on the projects. Additional research made by Cusack (1992) states that poor follow-up on project quality outcomes for example poor selection of subcontractors , poor skilled workers , weak project supervision results in 10 percent rise in project amount which is due to triggering of reworks.

2.2.4 Reworks related to vendors.

Project team members taking care of the project procurement must be upgraded in a way to minimize the project reworks going forward in the project completion (Love et al. , 1999). This is universal truth that completion of project on schedule and on cost deeply dependent of stakeholders interest (Chan, 1998; Faniran et al., 1999; Walker, 1994). It is additionally noted that low quality material preferences always originates reworks (Josephson et al. 2002).

2.2.5 Reworks related to Transporter

Transportation shall be handled carefully , any change in transport schedule causes of risk of less knowledge for new driver to ensure safety , may cause mishap or accident , complication on construction site which all ultimately results in reworks and sometime life loss which is not atoll recoverable (Chan , 1998).

2.3 Reworks causes

Controlling budget in order to align project with impractical schedule/ milestones most of time results imbalance of project which keep adding of works repetition (Hwang and Low, 2012). (Ye et al., 2014) Most of the time development of unreasonable race culture among team members and weak/poor project management techniques concludes to nervousness and fatigue in the teams which unfortunately ends up with repetition of the works as well as schedule delay. There is no doubt repeating the uncontrolled tasks is major challenge especially in civil works industry internationally , many literatures highlights that repetition of works adds five to twenty percent on project cost in addition to project schedule delays. Let talk about Singapore reworks which usually occurs due to poor quality management has resulted 24 to 32 percent late completions from calculated project schedule which surly adding dramatic escalation on the project cost (Hwang and Yang, 2014). (Hwang et al, 2013) concluded that weak and unrealistic project management is the major reason of repetition of works not only in private sector but especially in government sectors. **So Poor project management** is one of the root causes of reworks on project which leads to project failures.

Poor construction machinery and low quality of work is categorized as second critical factor which results in rework in engineering projects (Ye et al., 2014). (Mamman and Omozokpia , 2014) explained that less professional staff , low quality of construction material and resources , rejections of site works after comparing it to project documents and schedule , less resources comparing to histogram , high rental equipment rate are major causes which dramatically effects projects timely and quality completion. (Doloi et al., 2012) concluded that unstructured manpower coordination are high utmost reason for rework. Technicians and engineers having strong educational back ground and experience are backbone in executing industrial and construction

projects further its management responsibility in guiding their staff to ultimate project goal. This concludes that project **insufficient project resources** erupts the reworks on projects.

While talking about commercial and owner are another major factor which adds repetition or reworks on construction projects which results in affecting all stakeholders on the project including the owner, results in project over schedule and over budget (Hwang and Yang, 2014). Such scenario is also explained by (Hwang et al., 2009) and (Abdul-Rahman et al., 2016); both are stating the issue as, project revisions and changes due to owner decisions are escalating and prompting the project reworks and results turbulence in team members. (Uttam and Bhirud, 2015) describes that major reason of variations demand is owner instruction to revise part of projects or comments of project schedule. Some additional causes of repetitions of the works are changing the project scope, revision of project specification, change in material procurement etc. (Akinsiku et al., 2012) Due to project versatile scenarios most of time unpredictable event elapse of the project whose cost normally beard by the owner and sometime falls in court of owner. These unpredictable events might be any universal adversity, countries political changing scenarios, changing the countries governmental authorities regulations are some of core points which affects project plan and may cause the reworks on project .Final we may states that **market and countries situations are among reasons of repetition of works.**

Design revisions / Errors / changes in drawings, specifications, and bill of quantities are another source of causes of reworks on projects (Abdul-Rahman et al., 2016). Stepping further (Ye et al., 2014) concludes that errors erupted on reasons of less understanding of project objective and scope of among the reasons of reputation of project works. Weak design and deep contractual techniques also leads to project failure. Weak project documents proved with professional experience destabilize the project required outcomes. In professional upper level of management

of projects and their way talking the project documents leads to revisions and repetition of works (Hwang and Yang, 2014). On the other side project teams some time not successful in capturing the errors even at stage of implementation which surely opens the door for project failure and reworks. From project management prospective unreasonable project time schedule erupts the uncertainty on the project and lead the project to disputes and failures (Al-Kharashi & Skitmore 2009; Mpofu et al., 2017).

The project successful finishing or incompleteness from perspective of its cost basis on type of project owner, design team, main contractor and its subordinates. Major reason of project success is totally the core perceptions of valuable professional's staff who comes forward and makes decisions at the spot when required (Ansah et al, 2016a). On the other side stakeholders are big teams having versatile experience , knowledge , vision , abilities. Only solution to lead by line is best communications techniques and on schedule weekly or monthly meetings according to project requirements. Whenever stakeholder is not acting as project demand requires it immediately triggers project reworks which later drags to failure. On the other way round due to project dynamic situations right decisions come up on time by implementation of best strategies, which results finally in timely project completion. Poor quality control in manufacturing industry come up 3rd reason for repetition of reworks in China (Akinsiku et al., 2012). This concludes that **stakeholder poor interest and their weak cooperation/coordination** with each other make ground of project reworks.

Works Repetition most of time erupted due to unreasonable less spending either from contractor end or its lies on client part ,hiding bits of information between stakeholders, delay answering from owner, weak communication among project parties , many errors in contract documents (Owalabi et al., 2014). Project changes are main cause of repetition of works , literature states that

causes of variations is mainly results of unplanned project meetings , weak communications between project parties, on top of them delay involvement of main contractors on projects (Uttam and Bhirud, 2015). This concludes that **poor communication** erupts works repetitions of the planned project.

2.4 REWORK MITIGATION STRATEGIES.

Implementation of Project quality considerable improves project performance and help in on schedule and on cost project completion which in inversely proportional to reworks on project site (Lahdenpera and Koppinen, 2003).

It is necessary to develop a strategy for win-win situation of all companies.

Zairi (1996, p. 35) studies conclude that core mile stones shall be established, these mile stones can be:

Bench markings can be done as points to achieve targets.

Team can be guided by establishing standard.

Quality Competition can be develop among different teams

Auditing can be as a best practice of avoiding rework.

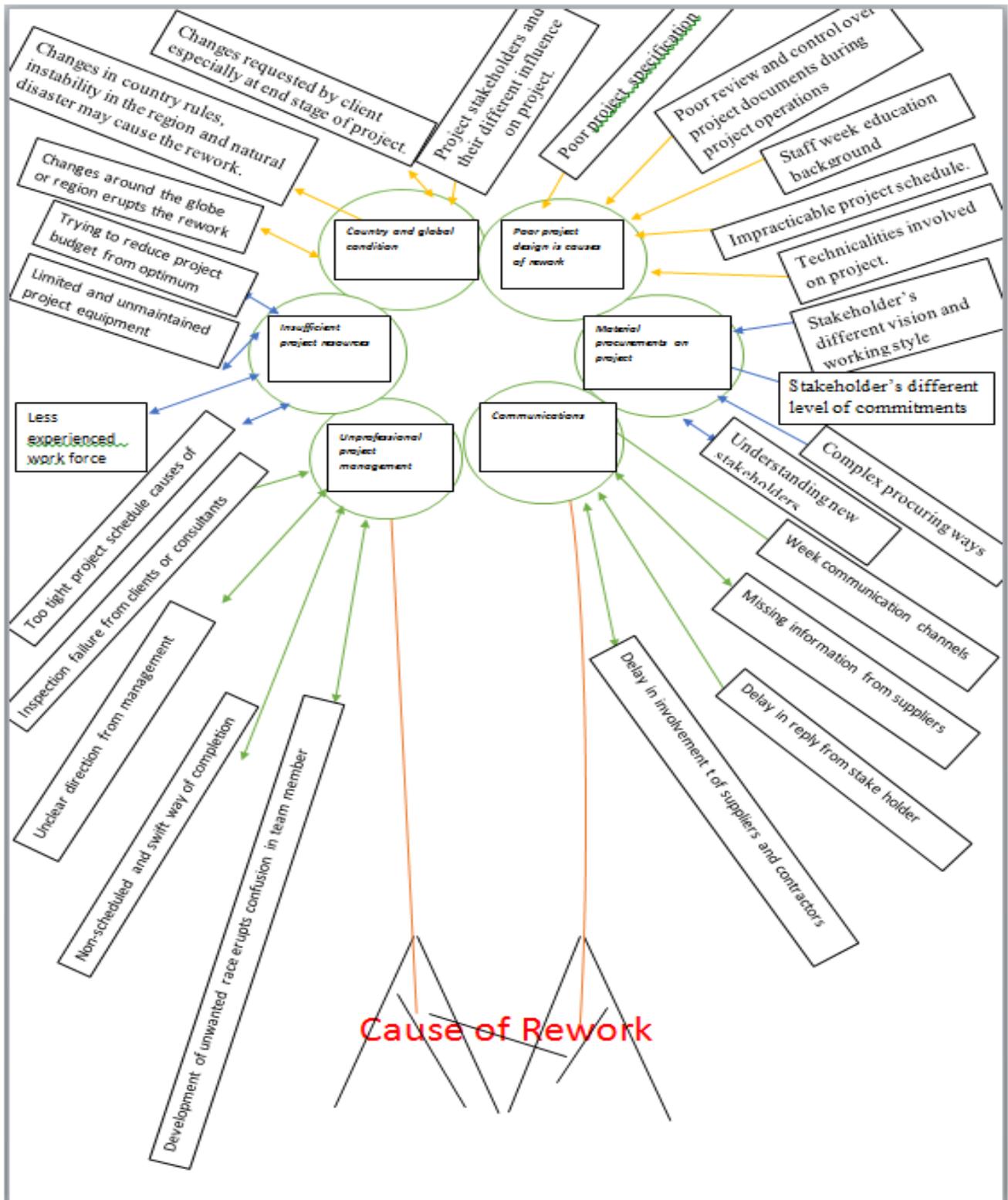
Projects involving deep technicalities can be best managed by facilitating project staff and awards system implementation .This management system is better than poor facilitating staff techniques (Meng and Gallagher, 2012). So many literatures write about implementing award system often leads to much better results specifically in harsh and difficult scenarios. Such incentives will not only improves project goals but as well as help in improving better relations which is the winning point for the management (Martin, 2003; Kohlmeyer and Drake, 2008).So results states that **bonuses awards to deserving team members and workforce** develop works interests in the staff which ultimately reduces to repetition of project works.

Change management is one of the factors which help in reducing project reworks. Sure its requires a dynamics on project on day to day activities for successful completion of project. It's very important to keep in mind client's attitude to be managed similar pattern. Each owner and project is running on some basic points which shall never be missed from day to day strategy (Kelly et al., 1992; Kamara and Anumba, 2000; Yu, 2007 and Yu et al., 2010b). (Hwang and Yang, 2014) describes that companies who always updates their management techniques accordingly results project completion smoothly which means reduction of works repetition of works considerable. Change management techniques must be implemented from early start of project to originate better results and over and above owner satisfaction. Change management shall not only be implemented internally insider of the company but its vision shall extend to beyond the sense which is internationally as well as around the region itself and revise the strategy accordingly. Although it require another set of team members but by the strategy company will emerge among performing company and dramatically improve performance and works repetition will automatically reduce (Oakland and Sohal, 1996). (Hwang and Low, 2012) concludes that stakeholders who use to thoroughly investigate the market and later according align their management policies and strategies results in considerable reduction of reworks on projects. Tender documents / feasibility documents are the base of creating lot of detailed project documents, means they are core of the project success. A detailed studies as well as research by saying without any discrepancies help in project successful completion and achieving project mile stones (Hwang and Yang, 2014). Project initial detailed study and finalizing reasonable project key performance indicators improve successful chances of completion and reduces project works repetition as well project budget and timelines be controlled. Execution of project works by planning reduced level of repetition of works always lead to project success as well as improve

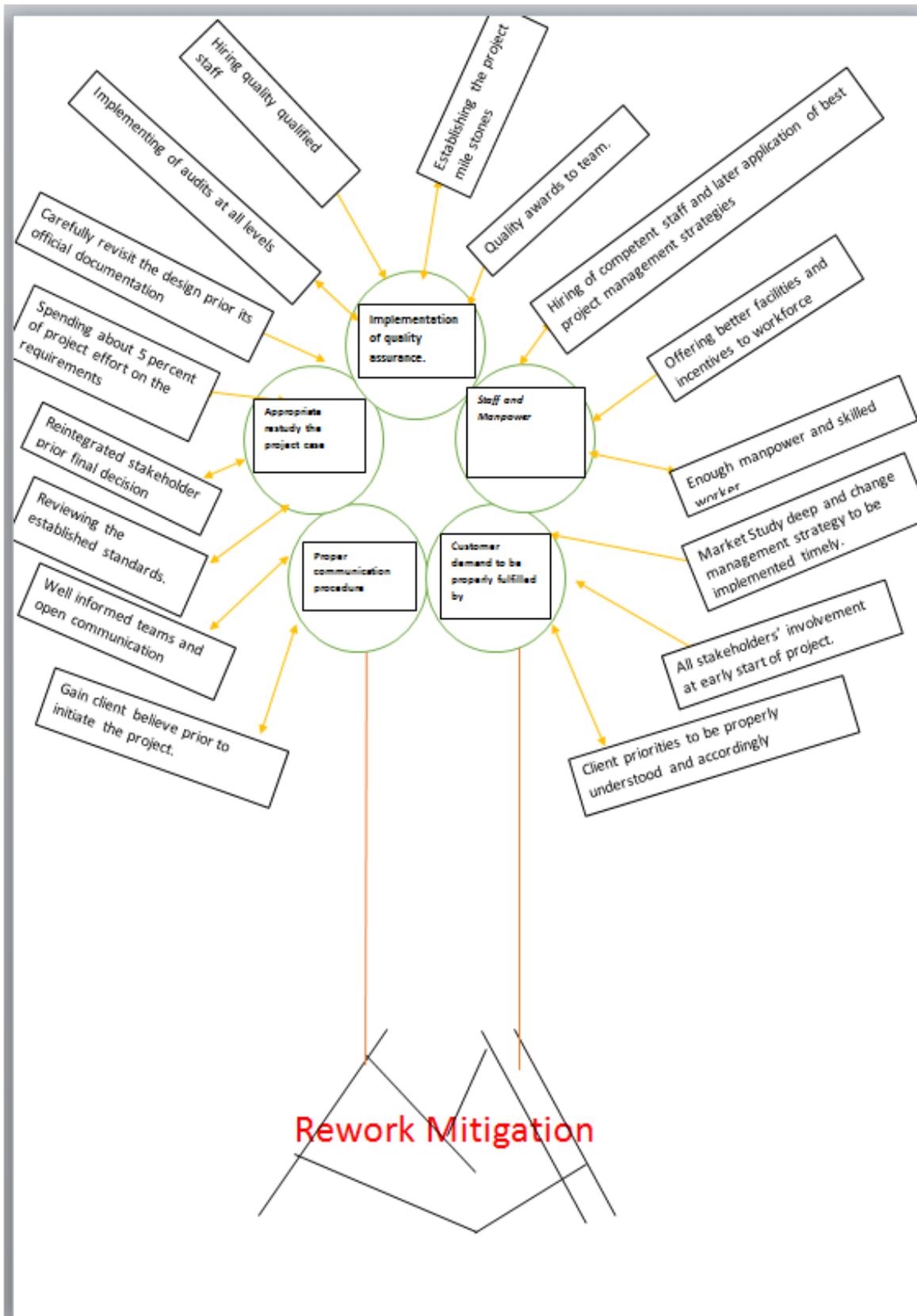
project quality and enhance procedures (Schaffer, 1992). So in conclusion **project deep vigilant study** may reduce considerable amount of project reworks.

(Blyth and Worthington, 2001) concludes that all team stakeholders must be on same page of communication. (Kujala et al., 2005; Arayici et al., 2006) The owner is the one who is investing on the project and as well he ultimately has to bear the good or bad from the projects. So he must be heard loudly among all the stakeholders. Their requirement shall be on high priority and shall be addressed at earliest. Knowing most of owners always having defensive strategy during execution of project due reasons may be about job assurity. In any case their trust and involvement of projects is absolutely impacting. (Chan and Kumaraswamy , 2002) states that efficient **communication** lines among stakeholders and owner can be helpful in smooth landing of project and so results in less complications and reductions in reworks.

2.5 Conceptual Model, Causes of Rework



2.6 Conceptual Model, Rework mitigation.



3 Chapter 3

Research Methodology.

3.1 Introduction

There are qualitative & quantitative research approaches. In qualitative research methods are narrative research, phenomenological research, grounded theory, ethnographic research & case study. This research consists of quantitative research in which methods used are random probability sampling whereas other types are systematic, stratified, cluster and quota and non-probability sampling can be done by convenience sampling and snowball sampling.

In this dissertation survey questionnaire prepared carefully to conclude hypothesis results where data scale is nominal and ordinal. Respondent data placed in variable view and respondent results placed in data view on SPSS.

Hypothesis

H1: Control quality procedures affect the higher management results & projects outcomes.

H2: Deep review of construction projects adds value in enhancement of project contract papers which includes specification, bill of quantities and FIDIC conditions etc.

H3: Global dependent factors in literature review effect positively to global independent factors.

H4: Better implementation of communication procedures improves project outcomes.

H5: Competent staff and skilled manpower can help in reducing the resources related problems.

3.2 Pilot testing

Data scale consists of nominal and ordinal .Writer tried his best about precision of ordinal factors, cohesiveness of the items and further ensured that it's direct relation with research objective including aim by taking into consideration of professional advice. Finally the survey paper was reviewed in a way to reduce complication , rational approach and easy to work on and straight forward (Goh and Abdul-Rahman , 2013) , after extensive repetition questionnaire was handed over to 20 management members to confirm that its elaborative , reliable and complete (Love and sing , 2013).

3.3 Independent Variables

Earlier researches has studied about independent variables and their enter relation to each other .Inspire still projects are suffering from schedule and cost overrun, as each project is unique and having its own challenges. This research further elaborate the critical factors which causes the rework on construction projects and how to have a successful mitigation .These variables are already validated in earlier researches. The factor studied in this assignment is used by many other researchers including (Fayek et al., 2003; Hwang and Yang, 2014; Josephson et al., 2002; Love, 2002, Abdul-Rahman et al., 2016) and others as mentioned in literature review.

3.4 Dependent Variables

These variables are registered how best we can avoid reworks to have a best project progress. These dependent variables add value to current literature. Note that earlier studies has been done but still we are unable to control the project at ultimate .We need to look further beyond to these dependent factors. In this study the mitigation dependent variables are week project management ,

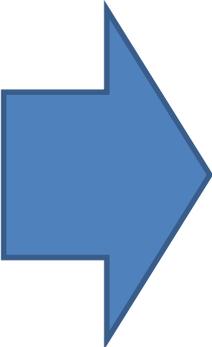
old machinery and unskilled manpower, region situation, design issues , supplier and communication issues.

3.5 Methodology

Survey questionnaire written by deep studying literature review. It constitutes of major factors which are active in causing the reworks and further mitigation techniques to control the construction reworks. Survey papers are having four portions. Its first part explains about ethics and explains the professionals about creating and importance of research study. Following the ethical there is demographic section. Later 6 factors which are having 27 items are highlighted which are core causes of reworks. Then 5 mitigation factors which are having 20 items are organized in tabular form. Professionals are requested to show them opinions on five-point data coding system according to each of expertise and professional experience.

Independent Variables

Dependent Variables

Rework Mitigation Techniques		Root reasons of Project Rework
Application of quality control procedures		Poor project Management
Professional staff & maintained project machinery		Non maintained machinery and incompetent manpower.
Dynamic market strategy		Dynamic market
Deep project study		Project contract complications
Balance communication		Project supplier complications
		Poor Communication

Writer worked hard about reliability check points which are items cohesiveness, factors precision including ensured that all study relates to basic aim and assignment objectives with help of industry professionals. Finally question papers deeply reviewed to eliminate any concern to reader and make required questions short and well understandable.

The research paper has been completed by sending survey paper hard copies in addition to convenience sampling. One of difficulty faced was UAE population consisted of considerable percentage of expatriates with busy job routines and other busy commitments. It was the hardest part in collecting appropriate replies from the professional people. In result I was successful in getting the limited response and appropriate answers were another big challenge (Ellsberg and Hesis, 2005).

In order to complete the survey works the question papers delivered via monkey survey, mails as well as hard copies. Survey reply was on average but its noted that some of professionals did not study well in order having appropriate replies. Question paper was delivered to 300 professional engineer among 103 find appropriate for further working in order finding crombak alpha , regression and correlations in SPSS software. PIE chart details.

I gathered 175 professionals for answering the questionnaire by my own people circle it's become only possible as I been in this country form last 18 years but it was not sufficient additionally I take help from BUID colleagues as well as from media help .Over than I ask my friends to help me by their similar fields colleagues.

Time arrived for collection of samples I was successful in collecting 155 filled questionnaire papers after studying the collected samples I included 101 samples in SPSS for concluding results and completing the task. Although the responses was less as expected. As construction

professionals require lot of efforts for chasing their key performance indicators and over doing some extra task without being benefited .I wish thank the professional members who provided nice inputs which made my SPSS results reasonable.

I also noted bit number s of questionnaire reply are inappropriate but respecting their fruitful inputs I loaded on SPSS so let software shows about regression and other analysis.

4.1 Introduction

SPSS used to conclude the survey results. Below frequency tables states the frequency numbers and percentage of respondents replied. Reliability tests test done by using cronbach’s alpha which shall be above .7 which shows data is highly reliable. later correlation table shown to understand the base for example the significance and arrow direction and strength of variable interactions in order to understand position of hypotheses. Going further deep regression test done of the data which calculates the variable value in presence of other variable. If value is higher its concludes high significance.**Results and discussion for cronbach’s Alpha.**

Reliability Statistics

Cronbach's Alpha	N of Items
.820	24

	Cronbach's Alpha if Item Deleted
Week Management	.810
Week Management	.806
Week Management	.801
Week Management	.801
Resources	.826
Resources	.819
Resources	.839
Resources	.832
Region	.812
Region	.810
Region	.801
Region	.816
Design issues	.811
Design issues	.816
Design issues	.821
Design issues	.831
Suppliers	.818
Suppliers	.815
Suppliers	.809
Suppliers	.810
Communication	.799
Communication	.807
Communication	.816
Communication	.799

Statistics applied on survey results study as shown in above table. First of all questionnaire prepared and its reliability measured. Causes of rework and its mitigation ways correlation found quite significant .Required chornbach alpha is .70, above table shows cronbach alpha .820 highlights that data is highly reliable and no multi collineratiy among the stated variables which I have referred for generating results.

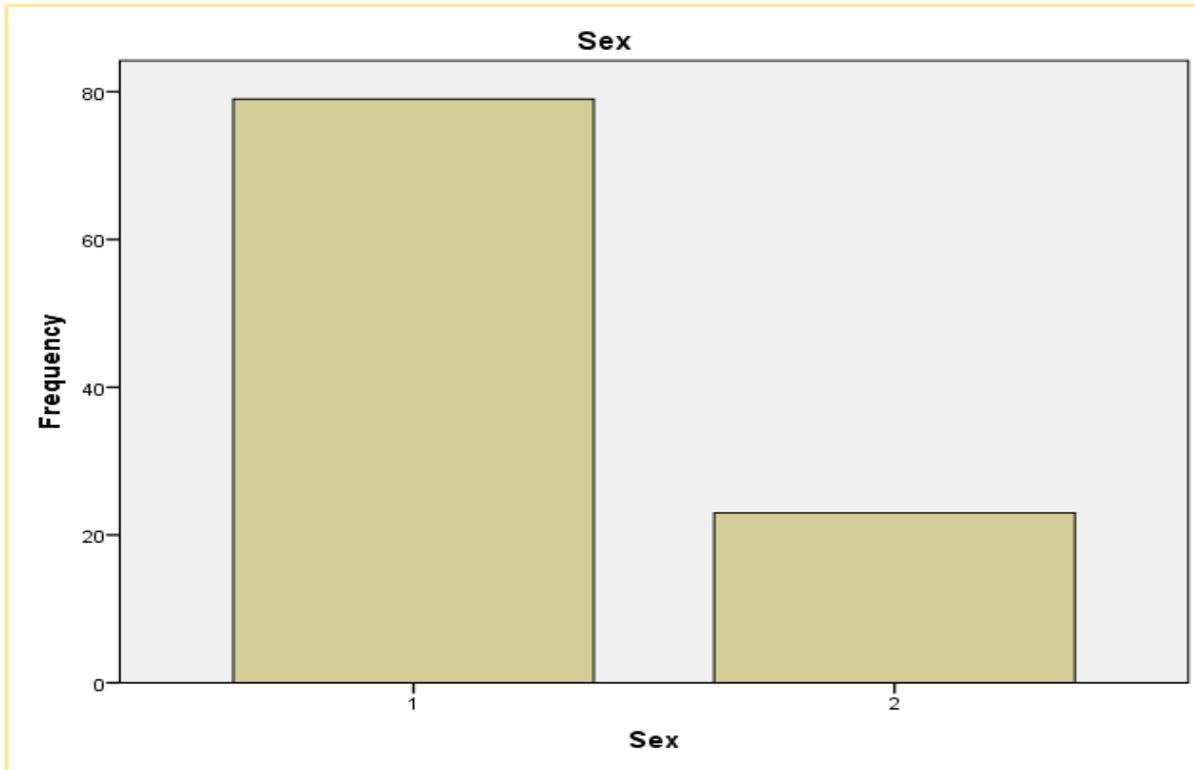
4.2 Results and discussion for Frequencies

The following is demographic information of surveyors which highlights changes in frequency and graphical representation of pie for data processed on SPSS.

Frequencies

Statistics		
Sex		
N	Valid	102
	Missing	6
Mean		1.23

		Sex			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	79	73.1	77.5	77.5
	2	23	21.3	22.5	100.0
	Total	102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		



Frequencies

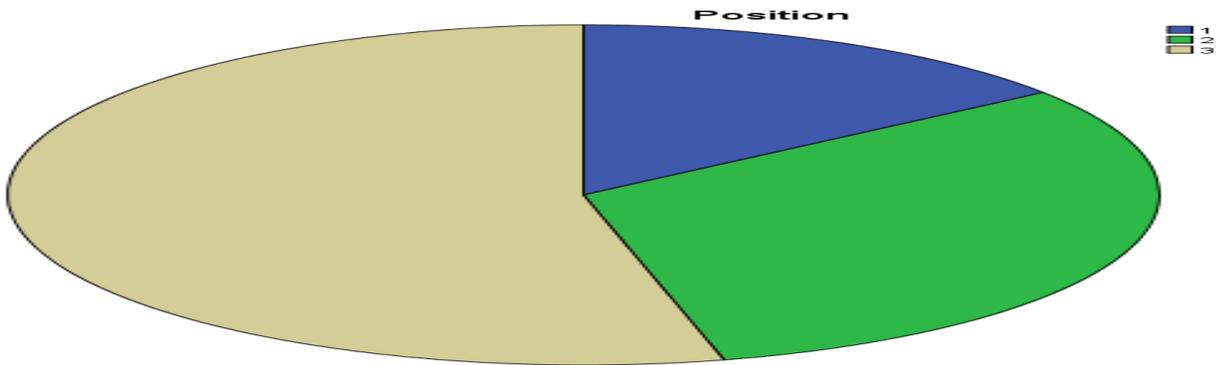
Statistics

Position

N	Valid	102
	Missing	6
Mean		2.39

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	15	13.9	14.7	14.7
	2	32	29.6	31.4	46.1
	3	55	50.9	53.9	100.0
	Total	102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		



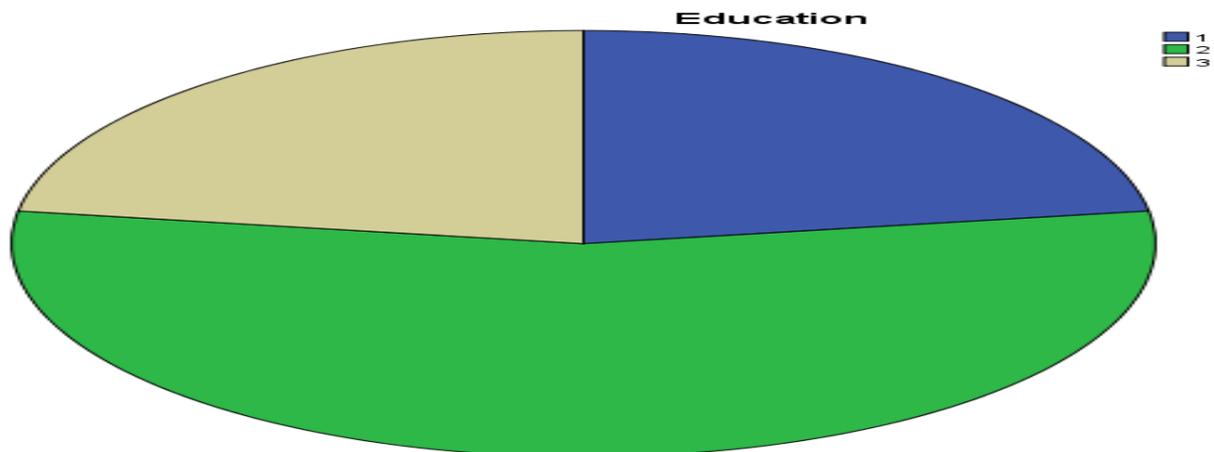
Frequencies

Statistics

Education		
N	Valid	102
	Missing	6

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	23	21.3	22.5	22.5
	2	56	51.9	54.9	77.5
	3	23	21.3	22.5	100.0
	Total	102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		



Frequencies

Statistics

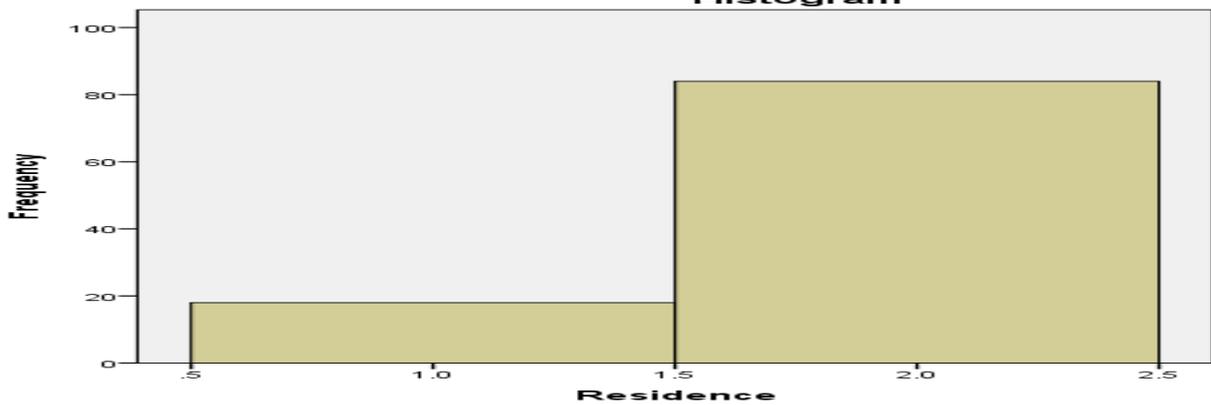
Residence

N	Valid	102
	Missing	6

Residence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	18	16.7	17.6	17.6
	2	84	77.8	82.4	100.0
	Total	102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		

Histogram



Frequencies

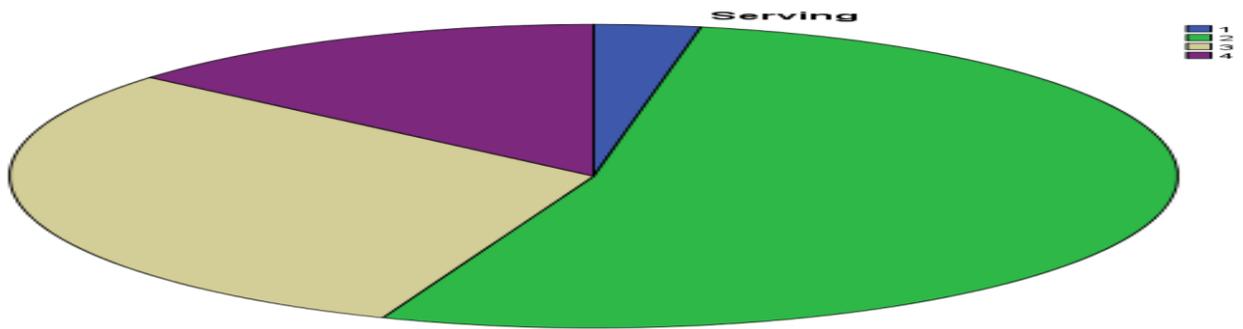
Statistics

Serving

N	Valid	102
	Missing	6

Serving

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	2.8	2.9	2.9
	2	54	50.0	52.9	55.9
	3	31	28.7	30.4	86.3
	4	14	13.0	13.7	100.0
Total		102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		



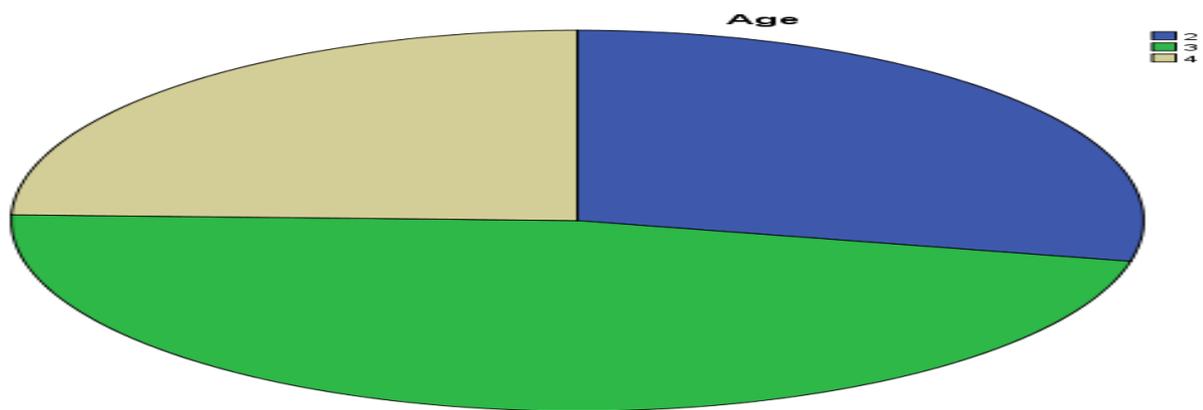
Frequencies

Statistics

Age		
N	Valid	102
	Missing	6

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	29	26.9	28.4	28.4
	3	48	44.4	47.1	75.5
	4	25	23.1	24.5	100.0
	Total	102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		



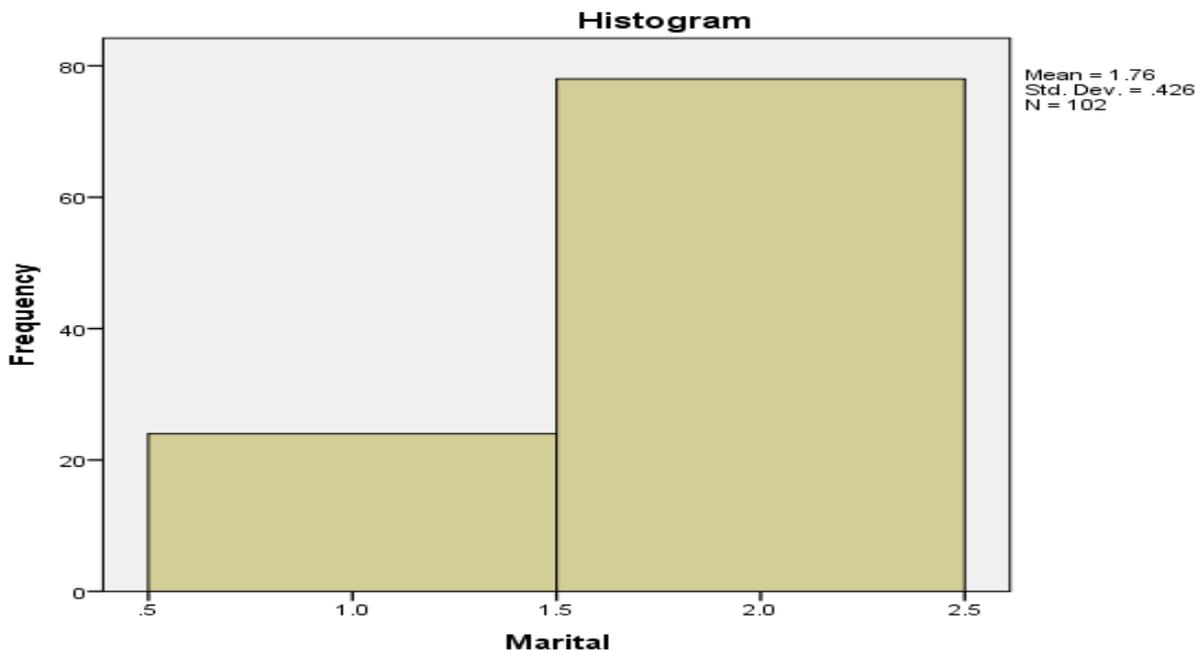
Frequencies

Statistics

Marital		
N	Valid	102
	Missing	6

Marital

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	24	22.2	23.5	23.5
	2	78	72.2	76.5	100.0
	Total	102	94.4	100.0	
Missing	System	6	5.6		
Total		108	100.0		



In the survey questionnaire 14% respondent is higher management 29 % respondent are middle management and 50 % respondent are engineers. Among them 22 % was females and 78 percent are male respondents. 23 percent surveyor have master’s degree and above 54 percent having graduation and 22 % are having college degree. As UAE is multicultural having less local population in result 17 % was local respondent and 77 % are expatriate respondents. About experience 3% respondent was having less than 5 years of experience, 50 percent was having experience between 6-10 years. 28 percent are having experience between 10-20 years and 13 percent were having experience above 20 years. Regarding age 29 percent respondents are having

age between 25 to 35 , 46 percent respondent are having age between 35 to 45 and 24 percent respondent age is above 45 years further 23 percent surveyor are unmarried and 72 percent are married.

4.3 Results & Discussion of Correlation

Correlations													
	week manager	Resources	region	design	supplier	communication	QAQC	Manpower	customer	restudy	connection	indept	depent
week manger	1	0.048*	0.074	0.051**	0.083	0.043**	0.041	0.086*	0.067**	0.045*	0.53	0.76	0.27*
Resources	0.045**	1	0.054*	0.234	0.765**	-0.431	0.097	0.543	0.921**	0.567*	0.098*	0.123**	0.023
Regin	0.063*	0.245**	1	0.098*	0.054*	-0.241	0.053**	0.156*	0.065*	0.045**	0.067*	0.098	0.054**
Design	0.037*	0.54*	0.987*	1	0.098**	0.045**	0.043	0.278*	0.987	0.051	0.045**	0.098*	0.023*
Supplier	0.047	0.456**	0.056**	0.654*	1	0.345	0.034*	-0.049928	0.051	0.053*	0.034	0.234	0.045
communication	0.402**	0.234	0.987	0.054	0.034**	1	0.456	0.723*	0.0754*	0.045	0.567*	0.045**	0.067**
QAQC	0.78*	0.034	0.067	0.034*	0.023	0.054*	1	0.316	0.043	0.049*	0.345	0.034*	0.234
Manpower	0.045	0.054*	0.345	0.768	0.675**	0.965	-0.432	1	0.934	-0.034	0.234**	0.05	0.098*
Customer	0.065**	0.234	0.234**	0.045*	0.02	0.543**	0.456	0.108**	1	0.345**	0.012	-0.098	0.123**
Restudy	0.023**	0.01*	0.067*	0.05	0.034	0.01*2	0.654*	0.272*	0.876**	1	0.015*	0.345**	0.023*
Connection	0.01*	0.234	0.789	0.01	0.01*	0.098*	0.234	0.098	0.765	0.654**	1	0.123	0.012
Indept	0.53	0.054*	0.056**	0.03**	0.06	0.045	0.054**	0.29**	0.043	0.765	0.035	1	0.041**
Depent	0.266*	0.085	0.234*	0.54	0.345*	0.054**	0.654	0.205*	0.54*	0.043*	0.654**	0.567*	1

Correlation table significance of .05 is highlighted by * and .01 significance is shown by **. Due to words limitation I didn't explain all table but the the symbols are crystal clear.

4.4 Results & Discussion of Regression Analysis

Following quality assurance and quality control methods can improve the project management outcomes.

4.4.1 below regression analysis table shows results of hypothesis number one how quality procedures affects the higher management results.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.541 ^a	.293	.279	6.33510

a. Predictors: (Constant), indepemitig

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	862.927	1	862.927	21.501	.000 ^b
	Residual	2086.944	100	40.134		
	Total	2949.870	101			

a. Dependent Variable: Deptrework

b. Predictors: (Constant), indepemitig

Coefficients^a

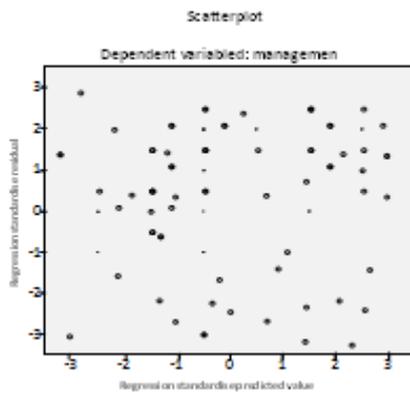
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.065	6.778		2.370	.022
	indepemitig	.604	.130	.541	4.637	.000

a. Dependent Variable: Deptrework

Table highlights that beta .604 showing sig. 000 concludes that applying quality control methods improves project management results. R square adjusted value 27.9 indicate increase in variance to project managers key performance indicators which means quality team should involve in site executions, submittal reviews and other project activities. Value F equal to 21.501 states that data

is significant concludes that implementations of quality project audits adds value to project schedule and cost control which means that reworks reduces dramatically.

Scatterplot



Results concluded that standardize residual is with in range as shown in scatter plot. Clustering is absent which states that the selected sample is in align with homoscedasticity guess.

Normal p-p plot of regression standardized residual

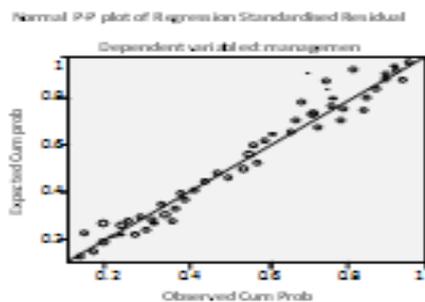


Figure highlights that all the results line in approximately straight diagonal which is from below left to up right. The result conclude no abnormality as well as it's linear.

Applying best quality assurance and quality control methods are directly proportional to improving project staff works, site works quality improves and not the least project performance indicators meets (Lahdenpera and Koppinen, 2003).Hwang et al. (2013) explains that project manager play an important role in successful completion of project, engineers better management considerable reduces the reworks on construction sites not only in government sectors but private sectors as well.

4.4.2 This study 2nd hypothesis states that deep review of construction projects adds value in enhancement of project contract papers which includes specification, bill of quantities and fidic conditions.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.274 ^a	.075	.066	2.22721

a. Predictors: (Constant), Design

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.269	1	40.269	8.118	.005 ^b
	Residual	496.044	100	4.960		
	Total	536.314	101			

a. Dependent Variable: restudy

b. Predictors: (Constant), Design

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.958	.996		7.989	.000
	Design	.345	.121	.274	2.849	.005

a. Dependent Variable: restudy

In above table the regression analysis shows that beta equal to .345, sig is .005 concludes if construction projects restudy carried out it improves project deliverables and helps in completing

the project successfully. In addition R square value is 7.5 percent indicates increase in variance which indicates that project restudies improves 7.5 percent improvement in design value. Further F equal to 8.11 indicates data is significant which also heights the positive results can be achieved by spending some extra time and resources on restudy of project.

Normal p-p plot of regression standardized residual

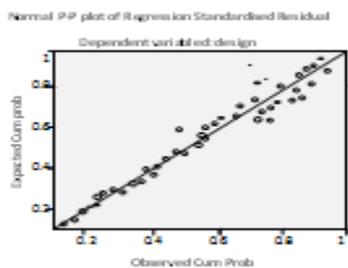
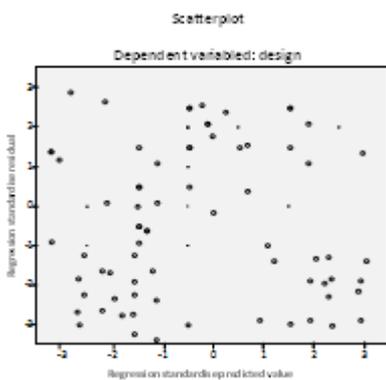


Figure highlights that all the results line in approximately straight diagonal which is from below left to up right. The result conclude no abnormality as well as it's linear.

Scatterplot



Results concluded that standardize residual is with in range as shown in scatter plot.

Clustering is absent which states that the selected sample is in align with homoscedasticity guess.

(Alaryan et al. 2014) states that applying versatile control techniques, deep and elaborative study, putting extra budget on design documents to review thoroughly and project changes need to be done at earliest will help in achieving project milestones and reduces lot of reworks.

Project base is the always the initial studies and design documents from where rest detailed documents are developing .It is only possible in achieving the project desired outcomes and target if there are minimum variation and only way of reducing the reworks at site and save the project cost.

4.4.3 3rd hypothesis.Global Independent factors effects positively to global dependent factors.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.535 ^a	.286	.279	6.31174

a. Predictors: (Constant), indepemitig

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1596.503	1	1596.503	40.075	.000 ^b
	Residual	3983.811	100	39.838		
	Total	5580.314	101			

a. Dependent Variable: Deptrework

b. Predictors: (Constant), indepemitig

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.752	4.880		3.433	.001
	indepemitig	.592	.094	.535		

a. Dependent Variable: Deptrework

In above table beta is .592 showing sig. 000 states that application of quality control procedures , competent staff and manpower , focusing on customer demand , reviewing the project case and better communication can dramatically reduce management weakness , machinery issues , design issues , supplier issues which is directly proportional in reducing project reworks. Additionally R square

Adjusted R sq. .279 highlights that project performance improves by 27.9 percent by implementing global dependent factors which reduces project reworks. F equal to 40 is significant which concludes that construction works progress and milestones achievement can be easily achieved by implementing subject global factors.

Normal p-p plot of regression standardized residual

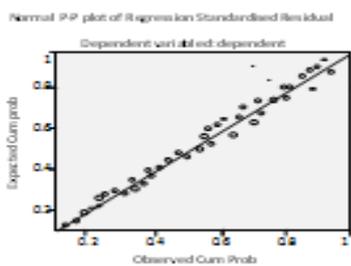
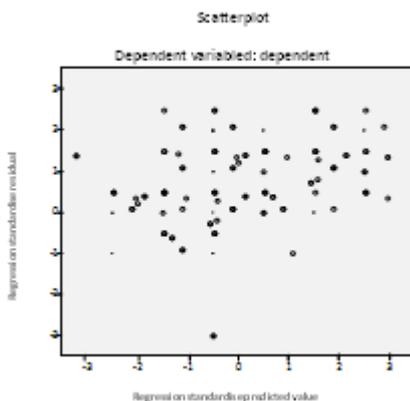


Figure highlights that all the results line in approximately straight diagonal which is from below left to up right. The result conclude no abnormality as well as it's linear.

Scatterplot



Results concluded that standardize residual is with in range as shown in scatter plot. Clustering is absent which states that the selected sample is in align with homoscedasticity guess.

Alexander and Stevens (2002) argue that five percent should be added to project budget which shall be utilize on improving project quality and its requirements. It is proved with the times that better grip on projects takes time parts of which could be type of project customers, digging the demands of project owner and its customers, understanding project technicalities as each project is versatile in nature. Competent and professional engineers shall be deployed in gathering and organizing the project requirements at soon as possible. Project reworks can be considerably minimized if we better control the quality.

The findings of this assignment conclude that all noted factors considerable impacts the project and their proper implications influences the construction projects positively. Factors noted was project staff, project histogram, project documents, country own situation, owners, contractors, and better communications to be controlled in order to get fruitful project outcomes. To conclude each project is different from others from its team, area, contract documents, demands, stakeholders and many more differences. Keep all these aspects competent management team and engineers require coming up from all these different challenges.

4.4.4 4th hypothesis Better implementation of communication procedures improves project outcomes.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.247 ^a	.061	.052	1.51042

a. Predictors: (Constant), Communication

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.853	1	14.853	6.511	.012 ^b
	Residual	228.137	100	2.281		
	Total	242.990	101			

a. Dependent Variable: Connection

b. Predictors: (Constant), Communication

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.519	.596		10.942	.000
	Communication	.152	.060	.247	2.552	.012

a. Dependent Variable: Connection

Communication.

Subject table explains that beta .152 showing significance 0 concludes that implementation of better project communication procedures help in reducing the project reworks, misunderstanding and confusion additionally R square is highlighting that 5.2 percent variance positive change happens and project manager may complete project in more easy way.F 6.5 is significant and illustrates better project outcomes by paying attention to project communication.

Normal p-p plot of regression standardized residual

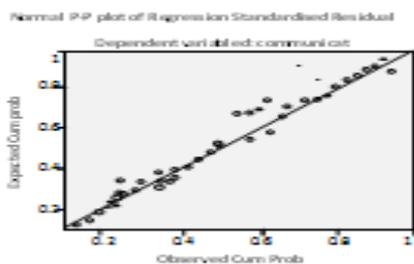
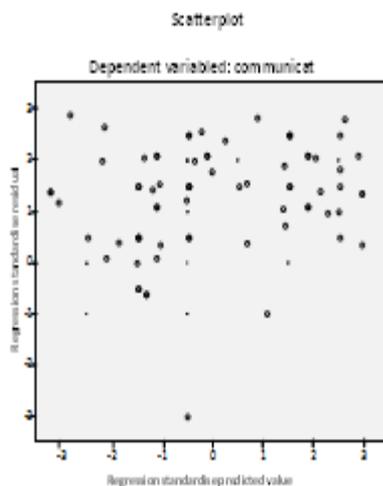


Figure highlights that all the results line in approximately straight diagonal which is from below left to up right. The result conclude no abnormality as well as it's linear.

Scatterplot



Results concluded that standardize residual is with in range as shown in scatter plot.

Clustering is absent which states that the selected sample is in align with homoscedasticity guess.

Early involvement of contractor on projects make the picture more clear and important stakeholders valuable inputs enhances the project success chances by reducing project reworks.intigrated project stakeholders and their collective and clear efforts improves project performance (Hang & Yang, 2014). Weekly and monthly meetings are better ways to keep client, contractor, subcontractors, project management team well informed about project updates and required improvements can put on table and conclude results. Better communication of project help to understand project complications well ahead and may be sorted out at early stage without harming the project and better control on cost and schedule which automatically reduces project reworks (Hang & Yang, 2014).

4.4.5 5th hypothesis

The research fifth hypothesis is that competent staff and skilled manpower can help in reducing the resources related problems.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.301 ^a	.091	.073	1.42121

a. Predictors: (Constant), Manpower

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.469	1	10.469	5.183	.027 ^b
	Residual	105.031	100	2.020		
	Total	115.500	101			

a. Dependent Variable: resources

b. Predictors: (Constant), Manpower

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.100	1.014		10.946	.000
	Manpower	.180	.070	.301	2.577	.012

a. Dependent Variable: resources

Above result ($\beta = .180$, sig. = .00) confirms that skilled manpower on project reduces the resources related issues. Competent staff and skilled manpower effects the 7.3 percent positive variance to resources problems. $F=5.183$ is significant at $P<.001$ which shows that regression table concludes that resources problem can be sorted out.

Normal p-p plot of regression standardized residual

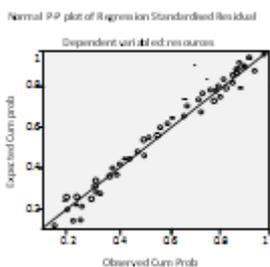
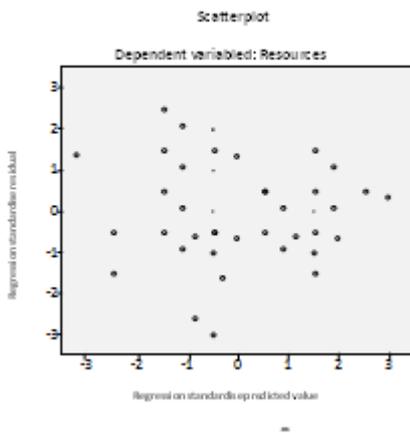


Figure highlights that all the results line in approximately straight diagonal which is from below left to up right. The result conclude no abnormality as well as it's linear.

Scatterplot



Results concluded that standardize residual is within range as shown in scatter plot. Clustering is absent which states that the selected sample is in align with homoscedasticity guess.

Less man-hour than demand triggers Repetition of activities, which results in additional cost as well as additional time comparing at planning stage (Bibs, 2013).

Technicians and engineers having strong educational back ground and experience are backbone in executing industrial and construction projects further its management responsibility in guiding their staff f to ultimate project goal (Hwang and Yang, 2014).

Hwang and Yang (2014) and Ye et al. (2014) research work concludes that hiring of competent staff and later application of best project management strategies are best methods in controlling the project problems which later leads to complicated situations.

The results and finding of survey papers concludes that the highlighted points or factors impacts better targeted project outcomes, speed and dramatically reduces construction projects works repetition. Further segregating the discussed factors project machinery, staff, project design including contract documents are applicable on any and each type of projects. Project location and political situations, type of stakeholders including subcontractors and internal /external communications to be handled considering the type of individual projects. Writing about concluding statement each and every project is different so project teams need to discover micro details about prioritizing the factors considering the specific situation.

5 Chapter 5

5.1 Case studies

Introduction

Each project has basic challenge to complete it according to project cost and schedule. But unfortunately most of projects failed in timely completion and on Cost due to limit less project complications.

I have been involved in construction projects from last 20 years. After thorough study of literature review and getting of successful survey results I compared it with 3 case studies. I successfully handled meetings with 5 project managers , 3 design directors , 2 resident engineer and presented my dissertation and later discussed the real life project problems which we faced during 3 projects execution . Later I tabulated each project rework issues and their solutions separately which are closely linked to my literature.

5.1.1 Case study 1

Project discussed in case study 1 was an industrial building project in Abu Dhabi recently which includes offices , workshops , substations .The project suffered with below discrepancies from stakeholders , the owners , design consultant as well as builder for example ,

- Reworks due to discovering of additional underground services.
- Reworks due to material procurement issues.
- Rework due to design issues.
- Reworks due to market situation.

Due to above reworks project delay for 8 months. It was operational project due to the reason client was in more lost.

Following table explains the actual reason for rework which caused project delay in schedule as well went over budget.

5.1.2 REWORKS ON ABJ INDUSTRIES:

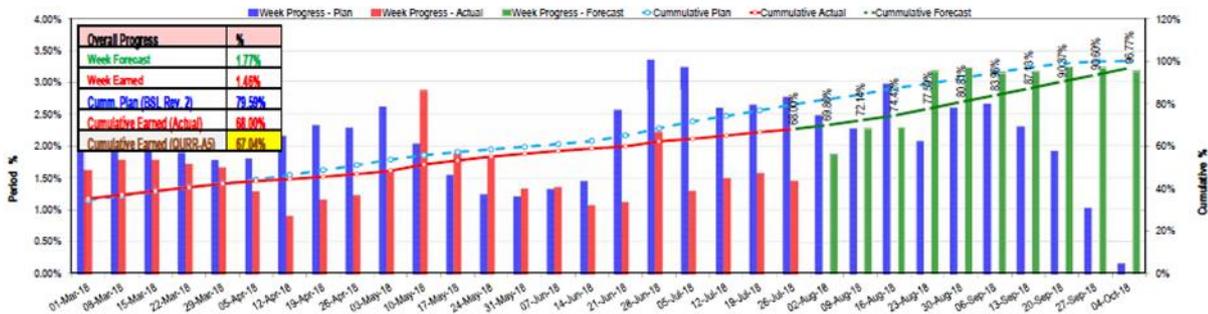
<p>Week project management & design issues Consultant got design approval and works started at site. Going forward extra existing services discovered during foundation digging stage. This project was under Dubai municipality. In result Building works stopped and contractor reapplied for approval to relocate the extra services. Authorities usually take some time in awarding approvals. Team was successful in getting approval after 3 months. This rework added in project delay.</p>	<p>Subject reworks caused due to poor project management and cost saving at tendering stage. If detailed study would have been done then uncover able delay and subject rework sure can be avoided. On the other side project director added that he has been working in gulf from last 32 years. Although it's was project management fault but gaps between construction authorities and rest stakeholders shall be reduced in order such reworks effects to be minimized.</p>
<p>Careful tender document and feasibility study This project consists of industrial buildings, workshops and reinforced structural works. The biggest steel structure was 400 meter in length and 120 meter in width. The below details added which caused lot of rework from stakeholders.</p> <ul style="list-style-type: none"> • Building K heavy crane added. • Building Q 8 workshop doors sizes were revised. • Additional beams were added due to revised design in building A. • 2 cat ladders were added due to AC unit's miscalculations. • Building dead load revised for block L due to additional equipment load and access tiling works. • Portal frame and canopy added for block A. 	<p>Client requirement proper study, careful tender document and feasibility study can have added value to the works. All the subject works like cancelling the earlier orders and reprocurement works can be minimized. Client would have saved 20 percent of project cost.</p>

<p>In appropriate hold on suppliers and distributors.</p> <p>Shortage on travertine marble faced on project. Contractor completed 8 floors and not started next due to shortage .Tiles were importing from France and there was shipment issues. Owner was in hurry so tiles design changed and rest balance quality remained on project till its completion and later discarded.</p>	<p>Companies shall select materials where it has branch office or at least staff might visit able to visit frequently for close coordination. Companies shall have 2 or 3 suppliers on the board so incase problem may arise in case can be sorted out at early convenience.</p>
<p>Market configures the project status.</p> <p>No one can predict the market which is universal truth. At initial project were having 15 building blocks. Owner constructed 7 blocks and stopped the work due to economic recession. After 3 years' time owner started the rework by revising parts of design and deeply new team.</p>	<p>Client must be having a competent team which always has a deep eye on the market while preceding such level of projects. By spending some of the dollars on market professions client could have saved design cost as well as redeployment of whole team.</p>

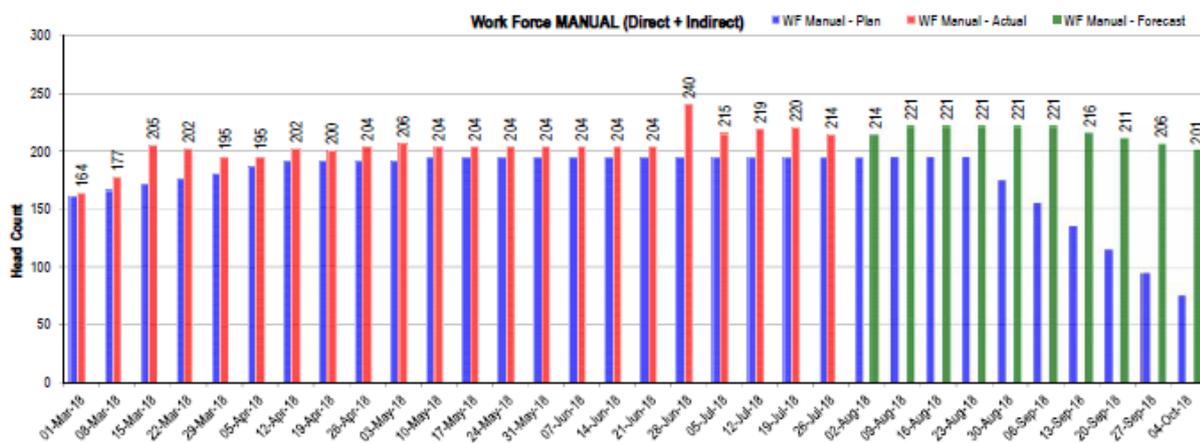
Due to reworks the project closed by increased budget and over schedule. Project completed 8 months beyond completion date even implementing acceleration techniques. Contractor applied for extension of time his time extension accepted but contractor was wishing to demobilize his team to new project which delayed them as per their planned schedule.

5.1.3 Project KPIs

When we talk about **planning** although project mile stones and key performance indicators details were tabulated for work packages. But 8 months additions due to discovery of additional services, many variations of projects, tiles procurement issues over and above 15 blocks were designed initially but unfortunately worked for only 7 blocks have disrupted all schedules. We can understand how important it is to control the reworks on construction projects.



About **resources management** rework occurred was on critical path where additional services were discovered. So in result manpower deployed on noncritical activities .It become hard to get a required production due to more manpower. But when municipality awarded approval then manpower become short and company deployed additional subcontractors to cope up the works. The objectives of hiring the extra manpower in order to control the critical activities to beyond to supercritical activities. The histogram helped in tracing the project on track.



The analysis with respect to **project budget** is to adopt a policy in order to accomplish the works in a way to control the discrepancies impacts which have imbalance the project due to reasons stated above.

Here affective action is required to reduce the impacts of reworks as project FIDIC clauses about penalty and liquidated damages will affect badly instead to for option of minimum profit or even

without profit. Lastly project cost was affected and acceleration was implemented to cope up the effects of reworks.

5.1.4 Nomination analysis & Results

The reworks causes on this case study are analyzed to see how they effected on project schedule, resources, project cost and decision making. The cases are analyzed to understand how reworks affects project progress .Decisions made by different stakeholders are judged and results concluded that owner is the one responsible for success or failure of projects especially in terms of reworks, although contractor part cannot be ignored at all especially when we talk about quality matters.

8 months delays due to rework on design approval is occurred due to contractor fault. Many variations (Reworks) on project were due to technical reasons and some were due to client miscalculations and confusion. Tiles procurement rework was due to contractor failure about his commitment with the supplier. Client paid design cost for 15 blocks and reworking the market situation compiled to reduce to 7 blocks.

The reworks nominations are on client & contractor part which was tried to managed by project acceleration as well as by implementing mitigation strategies as already discussed in project cost , project histogram and project schedule analysis.

5.2 Case study 2

The project was King Abdul Aziz International Airport project Jeddah. It is among the heavy projects. It consists of 400 bridge decks, internal roads and infrastructure works. The project was divided into 5 parts.

King Abdul Aziz International Airport (KAIA) DEVELOPMENT - PHASE 1 (VIADUCT & INTERCHANGE BRIDGES) CONSTRUCTION METHODOLOGY



Bridges & Infrastructure Project

<p>Less machinery and manpower erupt rework. Larger amount of storm water channels works were involved on the project. During concrete pouring operations unskilled manpower was less comparing to skilled manpower. Over than that contractor used loader bucket for pouring channel concrete instead of mobile chute.so concrete mixture faced bleeding concern over then poor workmanship resulted big crack on the surface. The case become in management eyes. Nonconformance issued by consultant and works reputation noted at site.</p>	<p>Contractor tried to reduce project cost by not deploying required machinery and manpower. Experiences have proved that each project have specific demand for successful completion of project. During submittal submission stage contractor must be asked to deploy required machinery. Folk of unskilled manpower is not at all replacement of just numbered skilled manpower.</p>
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<p>Design engineers having week educational background. Huge concrete operations were required on the project. Continuous concrete operations</p>	<p>Concrete design firm did not consider the project severity and complexity .Bridge</p>
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<p>were required on the project. Time arrived in casting the first bridge deck, management faced honey combing and voids while open concrete shutter. Later discovered that concrete workability was fine but having problem in its setting time. Work stopped for 1 month. Issue become on board on the other side many other decks were ready for concreting. The rework been done on the design again by the time 8 bridge slabs were ready for concreting works.</p>	<p>shape was complex with congested reinforcement. Mockup shall be executed prior to start of works. The subject scenario problem would have noted earlier and reworks and later project complications would have been minimized.</p>
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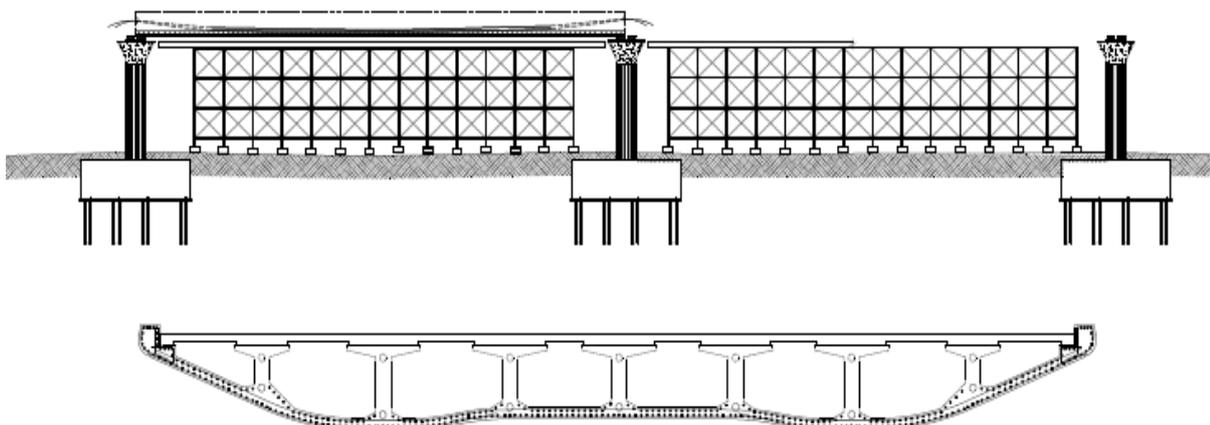
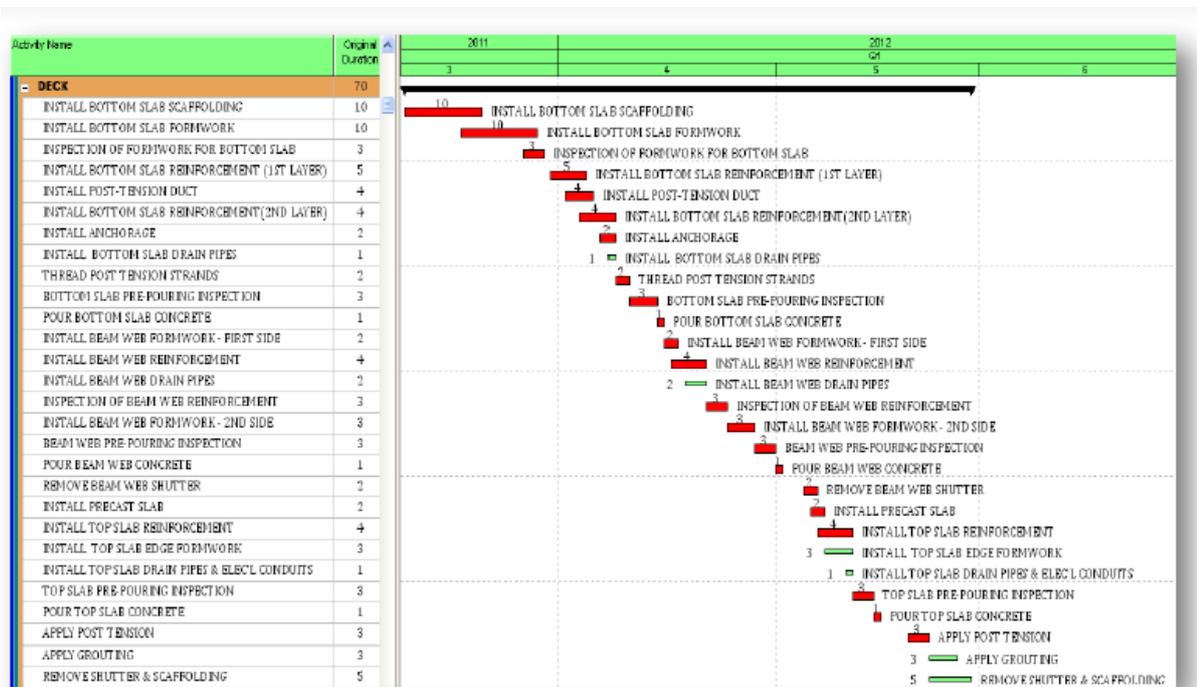
<p>None value added competition between among project members.</p> <p>Types of the bridges were 4, 5, 7 box girder bridges as well as bifurcated and trifurcated bridges. Although team faced problems at start of project later Works went smooth when systematic. When bifurcated bridge deck work started project manager was wishing to complete the project with the same pace. Measurement was taken and sends to workshop to cut and bend steel for the complicated diaphragm. The reinforcement diameter was 25mm and 32 mm.50 Ton steel been used on single diaphragm. When bended steel arrived at site and started fixation works, its bending was not proper. All steel wasted and rework been done for cutting and bending works. This all happened due to works urgency. Due to this problem project delayed for 1 month.</p>	<p>Proper standard operating procedure and task risk assessment shall be done for each of the activities. Different activities requires different focus and attention of the project .competition can be developed at hand on activities will is really fine. But the tasks which requires more deep study and knowledge shall be segregated .on this subject fault if 1 week had been utilized for extra carefully then 1 month extra rework would have been avoided including steel lose and further addition is loss of productivity and project extended beyond schedule.</p>
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<p>Unplanned and speedy way of completion Bridge bottom deck segregation</p> <p>Bridges width varies from 3 webs to 11 webs. Bridge decks are collection of congested reinforcement. Bridge bottom deck and webs take minimum of 2 months' work with heavy manpower resources.so at stage of concreting lot of dust and rubbish</p>	<p>Removal of cans, plythene bags seems a minor task .yes it is when team concentrates in removing them prior concrete works. but after concrete works it become really a challenge and it took 1 month for single</p>
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gather beneath the reinforcement. Due to urgency proper cleaning not been done. We found loss of dust particles, cans, polythene bags stick to bottom deck after opening the shutter. Know about remedial works, we either used mobile crane or erected scaffolding for this additional work.

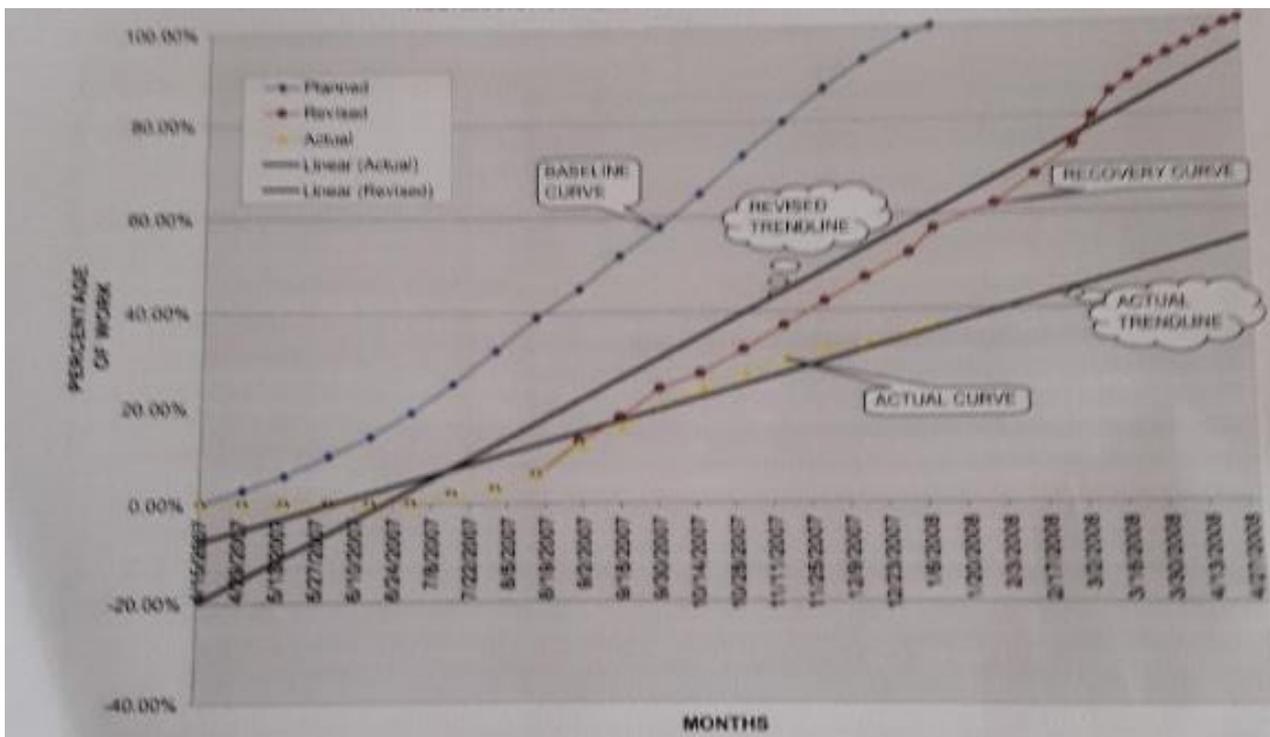
deck and just one can imaging about 400 decks. So not a single activity shall be overlooked .Project always found successful only after looking into such minor cases.

5.2.1 Work Breakdown structure



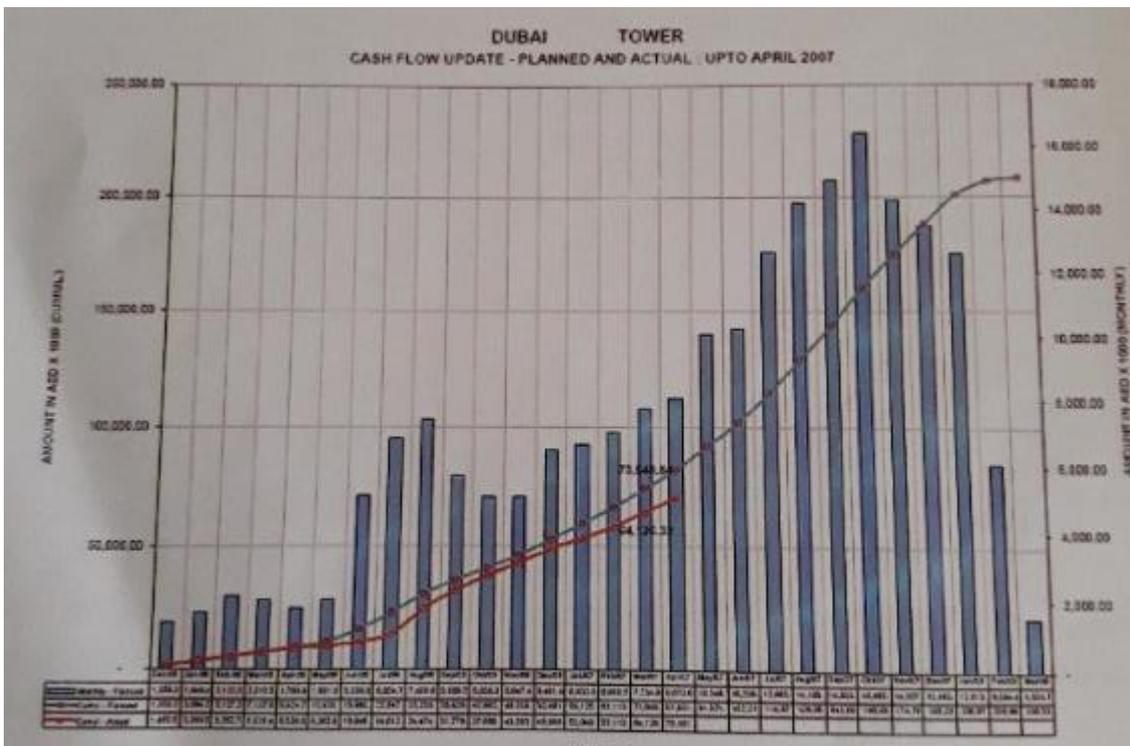
5.2.2 Project KPI'S.

Due to reworks on the project **base line programme** affected. Options for mitigating the delays due to reworks were considered as well as partial acceleration strategies implemented.



Delays due to reworks were reduced by implementing mitigation shown above in planning analysis. As the huge reinforcement works were ready for concreting but due to concrete redesign issues it was a great danger for reinforcement rusting and again sand blasting additional activity will have to be introduced in addition to weakling of **reinforcement. It was really a serious concern.**In result of these reworks the project recovery strategy was influenced due to versatile bifurcated decks which were requiring careful works and redesign concrete was an unrecoverable rework on the project.

About **resource management**, all manpower was utilized on finalized and approved activities. At start of project due to concrete design issues resources mobilized from the project .Going further channels works were rejected, workers needed to remove the concrete and redo the job again which utilized extra man-hours. Additionally reworks for versatile bifurcated decks and bottom deck cracks repairs took extra man-hours which delayed the project by 6 months.



The project scenarios as discussed impacted **the project cost** badly. Removal of rejected works added cost on the project .Redesign issue, versatile bridge deck and bottom deck repair added additional cost on the project. The situation affected the project badly even some of the subcontractors suffered for their payments from contractor end. Later case comes up in client notice and subcontractors got their invoice cleared.

5.2.3 Nomination Analysis and Result,

Redesign of concrete was consultant fault but rejections of concrete channels, bifurcated deck technicalities not considered at right time and bottom deck repair works were totally contractor fault which later they completed project in lose. Project schedule and its cost increased due to speedy completion. Project manager followed the complicated and straight forward activities with same attention which has resulted project reworks. In similar way design study was not that deep which resulted rework on project.

5.3 Case study 3

Roads and Infrastructure works Dubai.

This project consists of road bridges, foot bridges, 2 service tunnels and road works.

<p>Communication & insufficient project information. Substation concreting works were in progress under supervision of electrical company. While transformer trenches walls been build. It was highlighted by electrical manager that trenches sizes are not according to transformer requirement. In result reinforced concrete trances broken again carefully in order to avoid cracking of building foundations.</p>	<p>There was lake of communication between MEP contractor and civil contractor. Right standard operating procedure and risk assessment shall be implemented. Electrical engineer shall visit the site frequently and ensured proper implementation of drawings.</p>
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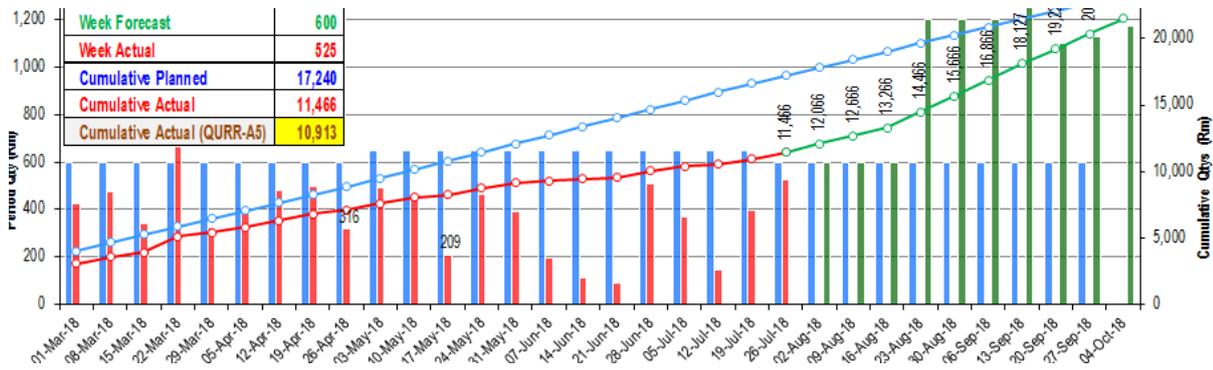
<p>Procurement and late hiring of contractor. Procurement is amount the most important deliverables on the project. Lots of types are available for even in selection of single material. Deep professional knowledge is</p>	<p>Earlier contractor involvement on the project reduces lot of reworks. Contractor is the one who has professional site execution team available for work. They are the one</p>
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<p>necessary for better selection of company and material type. Project specification was highlighting super silver glass to be fixed on all doors. While on site during contractor earlier project presentation owner changed his mind to grey reflective tempered glass. Supplier holed 10 percent deposited amount and further rework on was required with related stakeholders .project duration extended 3 months further.</p>	<p>knowing deep site problems at site. Contractor early involvement further strengthen the team. The design works can be thoroughly viewed important stakeholder on the project which will considerably reduce the rework on projects.</p>
<p>Slope protection in Saudi Arabia. Design engineer having week educational background Shape of slope protection</p> <p>Road length was 90 km it consisted of small, medium and some large sided slopes. Designer provided same section for all slopes protection irrespective of length. It worked nicely for small and medium slopes but for large slopes all the side sand erupted and slope damaged during rainy seasons. Later this protection was broken by project team and reconstructed.</p> <p>Cracks in tunnel</p> <p>It was a service tunnel which was excavated 20 meter deep. It was near to sea side .Bishop method was adopted for water proofing works .sufficient pumps were not provided for dewatering and always there found small amount of water gathered around structure. Which resulted cracks in tunnel walls which were 70 cm thick .Later professional teams called for survey works to investigate the problem. Costly repair material was used which as well disrupted the works progress .If contractor would have adopted better quality assurance and control procedures .Reworks would have been avoided with cost saving.</p> <p>Foundation excavation block B</p>	<p>Proper contouring study not done on project and over than that project team was not experienced who may judge the design mistake. Experienced team shall be hired on projects. Always reworks on the project harm the project schedule, cost.</p> <p>Management team ignored the minor leakage. As the concrete structure was not hardened properly and new. Water seep through the foundations into the walls. Walls did not achieve it full compressive strength. Concrete normally achieved 75 percent of strength in 28 days .Contractor planned saved budget but in response reworks occurred. Cost saving helps the projects but careful and calculative risk study to be done, likely scenarios need to be calculated and properly implemented.</p>

<p>Substation was adjacent to the big workshop which already existed. Excavation done for substation foundations but workshop foundation gets exposed and there become danger for building settlement .Later the issue brought up in management notice. Contractor was asked to refill all the area with concrete. So it was additional work for contractor which erupted due to week planning and improper communication.</p> <p>ADNEC steel bridge. There was foot bridge above tunnel to access the marine side. Its tower was a concrete structure, but due to improper project management king Khalifa visit to marine show was just a month ahead. It was decided by director to replace the half of concrete structure with steel structure .This was only way to complete the project even delaying 5 months .Due to subject reworks material procured on site wasted and team has to look for alternative to utilize the extra material. On the other side steel structure redesigned and steel material procured as well as professional team hired to tackle steel structure works.</p>	<p>Standard operating procedure and risk assessment not done. Contractor shall have studied the excavation method before start of work either to use a machine excavation or manual excavation. If contractor would have rigged manual excavation instead of machine excavation then heaving structure would have been protected. No reworks occurred in result.</p> <p>Although King Khalifa visit was successful. But due to poor management reworks originated .Project completed delayed over then extra cost and quality suffered.</p>
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5.3.1 Project KPI's.

Delay noted on **project schedule** due to reworks of substation trances, change in glass type to super silver step sol, redesigning of slope protections, cracks in the tunnels were repaired, additional works around building foundation due to poor coordination and half of concrete structure converted to steel structure . Base line programmer was revised taking into consideration of above reworks as shown in fig. below.



Above graph shows the planning analysis how mitigation and acceleration techniques are implemented. But the uncoverable rework delays were substation trenches breakage and its reworks as well as redesign of slope protection.

5.3.2 Result.

After implementing the mitigation and acceleration strategies glass procurement, substation foundation concern, service tunnel cracks reworks delay converted but substation trenches breakdown and slope protection redesign was uncover able delay which resulted 5 month delay.

Regarding resources management, additional resources deployed on substation trenching works. There were 3 substations on the project all were on critical path. Glass material procurement not affected the manpower because subcontractor on the project having a good relations with the company and he was already occupied on other projects as well. Redesigning of slope protection also did not affected the manpower as manpower remained in the same group and work on box culverts preparations work. Later team called back when design was approved. Regarding the tunnel cracks many external parties visited and submitted their quotations. Lastly one selected .some of activities remained stopped due to repair works. 800 man-hours additional added due to reworks on substation foundations. On the other side foot bride concrete structure converted to steel structure.

In conclusion, substation works and conversion of steel structure to concrete structure were critical which added man-hours mainly and project delayed by 5 months in total.

Regarding cost analysis substations works added consider amount to project budget but contractor bear the additional cost which affected his cash flow badly. Similarly some of slope protection failure and its redesign added load on project budget. Minor addition cost occurred due to discrepancies like Glass super silver step sole, 3rd party hiring for crack repairs and substation foundation excavations. Client beard the cost of replacing the concrete structure to steel structure in spite to quality worked suffered.

Contractor tried his best and negotiated with client about substations cost crisis, but client refused to mitigate due to contractor miscoordination though they provided best rates for super silver stepsil glass. On the other side contractor deducted 40 percent of the amount from subcontractor. Huge quality lapse seen by converting half of concrete structure to steel structure.

5.3.3 Nomination Analysis and Results.

Substation foundation and substation trench reworks was totally contractor fault and he managed all loses. Super silver step sol glass variation was from client. Slope protection redesign was consultant failure who deeply not investigated the case. Service tunnel cracks appeared due to less care to dewatering works which is also on contractor weak point. Client managed the variation of converting half of concrete structure to steel structure.

Reworks done due to poor design of slope protection, cracks was repaired in tunnels, excavation done near heavy foundation structure, part of foot bridge converted from concrete structure to steel structure.

6 Chapter 6

Literature review survey comparison with case studies.

6.1 Introduction

In this chapter SPSS results and case studies results are compared. It finally concluded that literature review hypothesis are totally applicable on 3 case studies and vice versa, both are proving positive relation which and deeply explained below in addition to related literature review highlights.

6.1.1 Week management vs. quality implementation (SPSS compression Vs. Case Study).

SPSS results about quality literature showed that application of quality audits , deploying competent staff and recognizing award culture helps in controlling project weakness some are foggy management instructions , works inspection rejection, On the other side case studies concluded that reworks originated due to cost saving at underground utilities investigation in case study 1 adding to that case study 2 showed reworks occurred due to concrete pouring on bridge bottom deck slabs without paying attention to proper cleaning it from dust , rubbish .although it seems a minor activity but just imaging that all scaffolding works erection for only cleaning the soffit of bridge and repair works and re inspection from consultant and it approval later dismantling of scaffolding .It all cost not only reworks but also delay the projects, wastage of unnecessary resources in addition to project cost.

Hence SPSS result considered with real case studies.

6.1.2 Project document application Vs. Careful Review and restudy prior application (SPSS compression Vs. Case study).

SPSS results concluded that by reviewing and studying the project deep study and its activities break down according to severity originates better end results i.e. completion of project on time and on schedule without avoiding its complications. In case study 2 whole reinforcement works considered as a one unit but the critical areas separate not studied and managed separately. After concrete pouring and while opening the shutter it was discovered that concrete operation went smooth in open areas while in complicated and congested part it showed poor result which caused the reworks.

In the other activity in case study 2, there were 400 bridges out of them 30 bridges were complicated due to their position and requirement. In start those 30 complicated bridges handled in same manner as normally bridges which resulted lot of reworks, confusion among the team due to the reason project suffered.

Similar case happened in case study 3 where on roads project there was 300 slope protection works out of them 25 was having long lengths and difficult terrain. It was handled by easy go and it all damaged and reworked due to heavy rain fall.

Hence spss survey results are considering with real case studies.

6.1.3 Reworks Mitigation global strategies Vs. Usual project management practices (SPSS results vs. case studies).

SPSS concluded that application of highlighted mitigation strategies i.e. QA/QC procedures, competent project team, owner demand and trust, restudy project cases and competent communication dramatically reduces project reworks. Now taking about my case studies in order

to save the cost mobile chute was used instead of loader which resulted cracks in structure, sufficient dewatering pumps not provided which resulted leakage which resulted reinforced wall cracks and repair works involved, concrete foot bridge structure transferred half part to steel beams and columns because project demand was to finish earliest due to prince visit which resulted poor quality control and which never been happened in my experience. All the subject discrepancies are result of not controlling the project reworks in proper way. Hence SPSS survey result concludes in a similar pattern.

6.1.4 Controlled communication vs. project communications ((SPSS results vs. case studies).

SPSS results concludes that better implementations of communications procedures are help full for project smooth flight and reduces the project complications dramatically. In case study 1 marble issue was raised as the material was importing from France. Delivery for marble delayed then again case was referred to design team. Matter was discussed with owner and later procurements procedure followed .In result project design was affected and delivery reached on project late by 4 month .so in result project schedule prolonged and extension of time given to contractor on the other hand project cost increased lastly project operations delayed.similary in case study 3 civil contractors casted concrete trenches which was not aligned with transformer requirements. The core base of the problem was that electrical and civil contractor not communicated properly. This case resulted breakdown of the reinforced concrete trenches walls which is not at all an easy job.

Real case study suffered in same scenario as SPSS conclude according to professional survey results.

6.1.5 Competent staff & skilled manpower vs. project resources (SPSS results vs. case studies).

SPSS final result showed that competent staff and skilled manpower considerably reduces project reworks. Additionally case study 1 results showed that many variations noted at project execution stage which resulted project reworks and delays in it. Another issue on the same project was 15 building were designed whereas 7 blocks constructed .which caused additional design payment and which was due to poor market studies. In case study 3 adjacent to heavy industrial structure foundation excavations done for substation. Which have caused beam and column cracked over the contractor was asked to poured concrete in the excavated area on their cost and they repaired building cracks. Although permanent damaged happened on structure .this all happened due to unprofessional project team and miscoordination.

Hence SPSS survey results and real case studies are aligned.

6.2 Discussion & Conclusion about Comparison (SPSS results & case studies)

6.2.1 Week Management vs. Quality Implementation.

Controlling the management issues teams must be having meetings to share vision to deliver the successful project. A visionary team totally depend on manager capabilities .Then its manager capabilities to rephrase vision into particle implementation which surely helpful in reducing the projects reworks .It's also recommendable to keep an eyes on team outputs and making them align according to change in project requirements (Wellman, 2012).

Adding to above at initiation of project things use to be taken too easy and many important issues mismanaged , this attitude not only drastic for project schedule but also affects team relationships and lastly adds the reworks at middle or end stage of project (Wellman, 1995).

In maintaining the project quality on of the way is implementing the reward system which can be accessed by the project managers to discover the best team member and appreciate them as much as they can during month, biannually or annually ceremonies (Kowta and Chitale, 2012).

6.2.2 Project documents review & restudy

Companies must take a step for required trainings for team members who reasonably capable of thinking forward and catch some of the discrepancies during restudy of projects. Such steps increase the chances of project success.so in subject scenarios impacts the engineers decisions either doing any risks studies or restudying the projects (Davison & Blackman, 2005).All these practices results in innovative and well advanced project approach which develops interests in team members and results in getting success in order to accomplish the project which results in reducing the project reworks (Hoegl & Parboteeah, 2006).

Going further a recognition plan to be implemented which pushes the management to keep an eyes on best decision makers /team members and later appreciate those selected team members to keep up team members moral (Kowta and Chitale, 2012).

Project Dynamics & variations changes project balance:

(Hoegl & Parboteeah, 2006) states the necessity of reflex during project executions which is the end result of versatile and innovative techniques and competent team. Able and best project staff are responsible, vigilant, active and always keen to enhance the project progress by implementing different strategies which are possible on project success.

During projects restudy members should be vigilant about project dynamics and make decisions according to owner's requirements. Project adjustments shall be done on priority basis according to project dynamics.Duing reviewing or restudying on thing to consider is that project members

must be having freedom to flag the noted changes, give suggestions and finally team discusses the end conclusions to put the results in place.

Especially construction projects having a versatile quality that many changes happen from day to day which changes the project equilibrium and proportionally it induces the project reworks.”

Gestalt professional cycle is the best way of describing the ways based on the statement that any new additional changes the equilibrium in project activities now it's time for team member to tackle the change and implement in best way on project which will bring construction project at new level of equilibrium now this new position is better than the previous position (Zwikael & Bar-Yoseph, 2004). In the same way things are getting revised and project finishes at its best levels.

6.2.3 Reworks Mitigation global strategies Vs. Usual project management practices

In order to reduce the reworks teams must be having innovative capabilities .Although on projects lot of manpower and resources and modern technologies are operating, best integration of all these deliverables are important in order to generate required goes and objectives “If there would be aligned, cohesive and unity among project staff target commitment and staff performance review will ensure innovating thinking which results in reducing the project reworks (Locke et al, 1988).

6.2.4 Controlled communication vs. project communications

Usually many stakeholders are involved especially on construction projects so in result many suggestions and talks are involved while completing the project deliverables. When team members and stakeholders shares and implement their experiences and finally results use to be very positive and sure would cause less chances of reworks (Koskinen, Pihlanto and Vanharanta, 2003).If a team works and treated equally results project works accomplished by mutual sharing which

reduces chances of rework.so differences in the team to be minimize so team works at a tandem for end fruitful results (Belbin, 2012).

6.2.5 Competent staff & skilled manpower vs. project resources

Projects are always versatile .Each project is having unique and different complicated steps. But the general controlling techniques are similar about cost, schedule, manpower and getting trust from different types of stakeholders and owners. Achieving project KPIs and milestones always demand competent team which may go deeper to capture project requirements and successful in understanding the cleavage plan of project.” Catching the project from bottle neck takes time, competent project teams takes the shortest time to understand the easiest ways by controlling the project challenges “(Wellman, 1995).

7 Chapter 7

7.1 Conclusion & Recommendation

7.1.1 Conclusion

Lot of literature is about reducing the construction reworks even then construction projects are facing the over schedule and over cost completion. The main cause is that each project use to be versatile in every way like its schedule and cost requirements, project locations and authorities involved as well as project staff and project documents and many more. Now all these complicated deliverables brings project cloudy pictures. My dissertation which has completed after extensive study is another mile stone in current literature.

The projects reworks are due to poor project management, less manpower and non-maintained construction machinery, area political background, contracts document complications, and stakeholders and communication issues. Then reworks mitigation techniques studied and highlighted in literature review which are helpful in reducing the project reworks. Later 5 hypothesis developed and were tested on SPSS which proved that all hypothesis support each other. Test done were chromback alpha, correlation, regression, Normal p-p plot of regression standardized residual and scatter plot.

Considering week project management resources, manpower, restudy, global dependent factors are having correlation of .05 while design, communication, customers are having correlation of .01. Full correlation details are highlighted in above table which concludes that project works reputation can be dramatically control by carefully applying the mitigation strategies.

Regression analysis concludes project management improves project outcomes highest which is 27.9 percent by applying quality control, results reduces reworks. Improving project communication increases project success by variance of 5.2 which results in reducing works reputation. Refer above statistical analysis for more details.

Normal p-p plot of regression standardized residual conclude no abnormality as well as it's linear for all 5 hypothesis. Scatter plot results concluded that standardize residual is within range. Clustering is absent which states that the selected sample is in align with homoscedasticity guess.

Later 3 project case studies discussed which highlighted project rework actual on ground. some are existing services discovered at later stage , project variations , project procurement issues , market changing demand, project quality issues due to unskilled manpower , concrete quality concerns, Issues due to deliverables different requirements , electrical and civil contractor communications issues, delay involvement of stakeholders, design issues , poor quality of works which causes tunnels cracks and many more.

To conclude comparison done between survey results and case studies , which proved that overlooking of Regions situation , project resources , weak management issues, project design issues , communication gaps , stakeholders discrepancies causes reworks which is crystal clear in 3 case studies as discussed and compared above. So SPSS results, case studies support each other and vice versa.

7.1.2 Recommendation

Main contractor should hold major responsibility of project scope & its deep core requirements and shall wisely adopt required strategy upon the acknowledged 6 reasons of reworks which

highlighted as stated above .The industry professionals must use the mitigation techniques stated above for project successful completion. Researchers may further dig deep detailed study on causes of reworks considering dissertation as a base root.

Due to my job responsibilities, my specific industry knowledge and time constraints this research done mainly on civil infrastructure works. So it may be recommended to widen the research works to other construction sectors.

7.2 Subjects that must focus in respect of UAE perspective

7.2.1 IDENTIFY REWORK RISKS

Any type of project weather it is heavy project or medium sized project rework sources must be identified with vigilant studies. All this data will provide a base reference before starting of any type of work. This might spread among related project team as a thumb rule before stating of any project.

A factual SOP shall be studied and prepared for any type of unseen events which may occur at any stage of project .The reworks that may occur identified must be tabulated on ranking basis. While works execution such point shall be carefully kept in mind and reasonable amount of budget and scope shall be allocated for any type danger that risk may occur.

Traditional way of calculating the danger of reworks and their further categorization shall be improved in a way by preparing break down structures as projects team used to prepare WBS.

7.2.2 Risk calculations and their Sharing.

It is important to calculate project risk and share in detail with team members. Risk is stated as any confusion that might impact the project in future. Risk may originate from bad project decisions, schedule concerns, weak vision and could be developed due to high competition. On

construction project risks may be high, low and medium. The following format shall be kept in mind for controlling the project reworks.

Rework risk factors	frequency	Probability	impact	mitigation
Each project has limited time period over than material and equipment bad quality are main sources of rework	high	high	High	Keep eye on project resources and schedule.
Team building and huge resources requirement are another cause of rework.	high	medium	High medium	Machinery and histogram to be monitored closely.
Different stake holder's requirement and interest generate a risk of rework.	high	medium	High medium	All stakeholders interest to be built in.
Any requirement change from client or unavailability of material causes rework.	high	medium	High medium	Contract document to be prepared after thorough study.
Project cash flow is also a source of rework.	medium	low	Medium low	KPI and cash flow to be carefully monitored.
The contractor might be involved in many other projects and failed to distribute required resources.	medium	low		Contractor shall be bound strongly by contract terms.
Variation may trigger the rework	low	low	Low low	Project changes shall be planned ahead

7.3 Innovative Teams helps in reducing reworks

Capable team members are core in reducing project reworks.

7.3.1 Efficient Team Members

Although companies are having best teams on board in order for its enhancing, the project manager shall look into members having similar capabilities and output levels must be grouped together. As well stepping team members considering their capabilities can help in identifying root causes well advance by implementation which enhances the team performances. On the other side deep involvement of project management team will help in dramatic increase in project progress. The project staff will observes that their senior level engineers are concerned and deeply following the deliverables in order to avoid reworks.

7.3.2 Reviewing plans enhances efficiencies and reduce reworks

Normally projects are having more than one construction managers. Construction manager works at all levels on sites. Their suggestions and recommendation can really helpful in reducing project reworks. This can be possible through monthly reviews. By updating the project strategies on day to day basis concludes to groundbreaking results and innovative teams. Teams always delivers best end result by implementing change management on the projects which results in reduced reworks.

7.3.3 Positive Culture Among team Members reduces reworks

In order to reduce the project reworks it is important having weekly meeting on discussing new ideas communicated by team members. These new ideas shall be tested and applied after deep judgment which can improve project progress and reduces project reworks. High level Reports shall be exchanged.

Its general practice that project cost and schedule reports forward to head offices and higher management merges it into their strategy .It is recommended that these reports shall be distributed to project management .Where new ideas will be generated for both site management and high level management .Such strategy reduces project reworks. Project managers can compare project dynamics with company strategy for better results. It concludes that when head office team and site management perform their duties as a tandem, team works like a business family, there are no difference among various cultures and everyone feel valued in such culture teams perform with devotions and interest which dramatically reduces projects reworks.

7.4 The following bullets are additionally recommended in reducing reworks in UAE projects,

- The government must introduce training programs by coordinating other industrial sectors to enhance managerial techniques for professional engineers.
- Interim payments shall be cleared in timely manner which reduce project pressure considerably results in reduction of rework.
- Reasonable project cost and balance project schedule is core in reducing project reworks.
- The government must continuously update its regulations and laws to reduce project time & complications.
- It important to have a common and proper grip between engineers when listening and understanding/interpretation customer ideas and suggestions .Proper implementation of client's ideas reduces reworks dramatically.

Above knowledge sure add value to civil engineering projects literature and wise reference for researchers and students to deep dip the empirical counting to best control the project at its

deserving schedule and cost. The application of this dissertation will enhance industrial professionals outputs by dramatically reducing the projects reworks. Reworks mitigation techniques further reinforces the reduction of project reworks. Reworks on building projects touched too less in this paper works as writer has less experience on the in building construction industry especially high-rise towers. Which is sure a limitation of dissertation. The writer has total 20 years of experience out of which 15 years in UAE and 5 years in rest gulf .So this papers in most applicable to Gulf especially UAE industry. Finally this paper sure having a capacity further strengthen and reinforce by taking this paper works to further levels.

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Causes of Rework and their mitigation strategies.

Appendix 1

Questionnaire paper format for final dissertation research works

Reworks causes and their mitigation strategies

A. surveyor information

1. Position in the company

Higher Management	Middle Management	Engineers
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2. Education Level

Masters and Higher level	Graduate Degree	College Degree
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3. Your Country

UAE nationals	Non UAE nationals
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4. Basic Role:

<i>Public Job</i>	<i>Private Job</i>	<i>Others</i>
▪ Government	▪ Client	▪ Describe
▪ Semi government	▪ Construction contractor	
▪ Indirect employee	▪ Consultant	
	▪ MEP contractor	
	▪ Advisor	
	▪ Project Management	
	▪ Material Supplier	

5. Total Year of professional experience?

5	6-10	11-20	20 & above
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6. Sex

Female	Male
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7. Age

25 to 35	35 to 45	45 to 55
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8. How long serving in the current originations

Less than 3 years	Between 3 to 7 years	Between 7 to 12 Years	12 years and Above
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9. Maternal Status

Married	Unmarried
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Kindly mark the critical factors marking either 1 to 5 , in which 1 highlights the top critical item , 2 highlights critical , 3 highlights helping factor , 4 states less critical and 5 represents lowest critical items which originates works reputations.

<i>Unprofessional project management causes modification on project</i>	1 st cause	2 cause	OK	Less	Least
Non-scheduled and swift way of completion	1	2	3	4	5
Development of unwanted race erupts confusion in team member	1	2	3	4	5
Unclear direction from management	1	2	3	4	5
Inspection failure from clients or consultants	1	2	3	4	5

<i>Insufficient project resources causes rework</i>	1 st cause	2 cause	OK	Less	Least
Too tight project schedule causes of rework	1	2	3	4	5
Less experienced work force	1	2	3	4	5
Limited and unmaintained project equipment	1	2	3	4	5
Trying to reduce project budget from optimum	1	2	3	4	5

<i>Country and global condition erupts rework</i>	1 st cause	2 cause	OK	Less	Least
Changes around the globe or region erupts the rework	1	2	3	4	5
Changes in country rules, instability in the region and natural disaster may cause the rework.	1	2	3	4	5
Changes requested by client especially at end stage of project.	1	2	3	4	5
Project stakeholders and their different influence on project.	1	2	3	4	5

Poor project design is causes of rework	1 st Cause	2 cause	OK	Less	Least
Poor project specification.	1	2	3	4	5
Poor review and control over project documents during project operations.	1	2	3	4	5
Staff week education background.	1	2	3	4	5
Impracticable project schedule.	1	2	3	4	5
Technicalities involved on project.	1	2	3	4	5

Material procurements on project may causes the rework	1 st Cause	2 cause	OK	Less	Least
Stakeholder's different vision and working style.	1	2	3	4	5
Stakeholder's different level of commitments.	1	2	3	4	5
Complex procuring ways.	1	2	3	4	5
Understanding new stakeholders	1	2	3	4	5
Manufacturing faults in materials.	1	2	3	4	5

Communications	1 st cause	2 cause	OK	Less	Least
Week communication channels [corridor, fax, email etc.]	1	2	3	4	5
Missing information from suppliers	1	2	3	4	5
Delay in reply from stake holder	1	2	3	4	5
Delay in involvement t of suppliers and contractors	1	2	3	4	5

Construction works reputation are reduced by applying the below described factors which are well.

Implementation of quality assurance procedures	1 st cause	2 cause	OK	less	Least
Performing quality audits at different layers	1	2	3	4	5
Deploying competent project team	1	2	3	4	5
Targeting specific interim goals	1	2	3	4	5
Award system implementation.	1	2	3	4	5

Staff and Manpower	1 st cause	2 cause	OK	Less	Least
Deploying competent project team and implementation of best practice	1	2	3	4	5
Providing better offers / increments to project staff	1	2	3	4	5
Sufficient staff and skilled manpower	1	2	3	4	5

	1 st cause	2 nd cause	OK	Less	Least
Customer demand to be properly fulfilled by					
Global Market variations and accordingly implementing best strategies at spots.	1	2	3	4	5
Contractor involvement at early project stage.	1	2	3	4	5
End user demand to be noted carefully and executed accordingly.	1	2	3	4	5

	1 st cause	2 nd cause	OK	Less	Least
Restudy Contract documents.					
Restudy project documents to avoid mistakes	1	2	3	4	5
Spare more time for project requirements listing.	1	2	3	4	5
Careful stakeholder's selections.	1	2	3	4	5
Restudying project milestones developed.	1	2	3	4	5
Variations to be discovered at project early stage.	1	2	3	4	5

	1 st cause	2 nd cause	OK	Less	Least
Better communication methods					
Well informed teams and open communication	1	2	3	4	5
Well informed teams and open communication	1	2	3	4	5
Gain client believe prior to initiate the project.	1	2	3	4	5

Appendix 2

Project owner is the one who either gains major profit from the project or either the ultimate loser because he has to live and handle the end outcome. Below is the client importance article on projects whose best strategy may reduce the construction reworks and enhance project success.

If construction organization needs to be successful its system shall be exposed system that welcome suggestions about manpower, procurement, cost, machinery as well as detailed information about client demands, client principles and laws which collectively feed to the best project completion (Pilcher, 1992). The client most of time less professional with complications of project, but sure every owner feel upset while project cost exceeded, their best interest is to limit the budget as much as possible (McNulty, 1982). But major decisions also done by client as well.

Therefore following are major things which owner should take care for In order to reduce the project reworks and ensure it on time and schedule completion,

- Clearly investigate their purpose and scope.
- Convey clearly about their purpose, objective and scope.
- Rightly calculate the project cost.
- Best selection of stakeholders (Project management, consultant, contractor ECT.)
- Understand and make core project decisions
- Thinking about best coordination between stakeholders.
- Guiding the stakeholder team as a leader.
- Finalize methods to calculate budget, invoices for stakeholders, project schedule.