Sudan University of Science and Technology

Faculty of Graduate Studies

M.sc in Construction Management

Impact of Project Scope Change on the Success of Building Projects in Khartoum State

اثر تغيير نطاق المشروع على نجاح مشاريع البناء في ولاية الخرطوم

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الإستهلال

قال تعالي :

{ فَاسْأَلُوا أَهْلَ الذِّكْرِ إِنْ كُنْتُمْ لَا تَعْلَمُونَ }

صدق الله العظيم

[النحل: 43]

Dedication

This study is wholeheartedly dedicated to soul of beloved Parents my Father Mohtadi Amin Alsunni any my mother Ehassan Yousif Khodary whom just passed away before seeing the result of their effort in my life, god bless him.

Whom have been our source of inspiration and gave me strength when I thought of giving up, whom continually provide their moral, spiritual, emotional, and financial support. To my brother, sisters, my wife, my sons, relatives, mentor, friends, and classmates who shared their words of advice and encouragement to finish this study. And lastly, I dedicated this Research to the Almighty God, thank you for the guidance, strength, power of mind, protection and skills and for giving us a healthy life. All of these, we offer to you.

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Abstract

Projects need to be performed and delivered under certain constraints. Traditionally, these constraints are scope, time and cost. The Scope Control process influences at the factors that lead to project scope changes and control the impact of those changes, which a key issue for project success.

This research aimed to identify ways adopted for identifying Project scope of work properly ,To identify and rank the causes for project scope change and to assess the frequency of their occurrence ,To measure the impact of causes of project scope change on project constraints and To measure the application of change control process in the construction projects in Sudan .

A questionnaire was then chosen as the main tool to be devised for data collection, Questionnaires were distributed to different parties in the construction industry, The sample comprised area is distributed as owners (37%), contractor (33%), consultant (25%) and academic staff (5%), the distribution of sample focused on the owner because he is the one mostly affected by the change of scope of work ,The questionnaire was analyzed using statistical analysis by Microsoft Office Excel to obtain opinions about Causes for change in scope of work and their impact in the constraints of project and how this change are managed in construction projects. The questionnaire was responded in ranking answers reflecting the audient opinion such as “Always”, “Often”, “Sometime”, “Rare” and “Never”.

The study concluded the steps that should be applied for define the project scope properly, the causes of scope change in Sudan, measuring the impact of causes of project scope change on project constraints and assessing the application of change control process in the construction projects in Sudan.

المستخلص

يجب تنفيذ المشاريع في ظل قيود معينة. عادة ، هذه القيود هي النطاق والوقت والتكلفة. وتؤثر عملية التحكم في نطاق المشروع على العوامل التي تؤدي إلى تغييرات في نطاق المشروع نفسه والتحكم في تأثير تلك التغييرات. وهو يعتبر عامل أساسي لنجاح المشروع.
يهدف هذا البحث إلى تحديد الطرق المعتمدة لتحديد نطاق عمل المشروع بشكل صحيح ، لتحديد وترتيب أسباب تغيير نطاق المشروع وتقييم تواتر حدوثها ، لقياس تأثير أسباب تغيير نطاق المشروع على قيود المشروع وقياسه. تطبيق عملية التحكم في تغير نطاق الأعمال في مشاريع التشييد في السودان.
بعد ذلك تم اختيار الإستبيان كأداة رئيسية لابتكارها لجمع البيانات ، وتم توزيع الاستبيانات على جهات مختلفة في صناعة التشييد بما في ذلك المالكون والاستشاريون والمقاول ،حيث تحتوي العينة على (37%) من المالك و(33 %) من المقاولين و(25 %) من الإستشارين و(5 %) اساتذة جامعين وتم تحليل الاستبيان باستخدام التحليل الإحصائي بواسطة Microsoft Office Excel للحصول على آراء حول الأسباب التي تؤدي إلى التغيير في نطاق العمل وتأثيرها في قيود المشروع وكيفية إدارة هذا التغيير في مشاريع التشييد. تم الرد على الاستبيان في ترتيب الإجابات التي تعكس المستهدفين مثل "دائمًا"، "غالبًا"،" في وقت ما"، "نادراً" و "أبداً." وخلصت الدراسة إلى الخطوات التي يجب تطبيقها لتحديد نطاق المشروع بشكل صحيح، وأسباب تغيير النطاق في السودان ، وقياس تأثير تغيير نطاق المشروع على قيود المشروع وتقييم تطبيق عملية مراقبة التغيير في مشاريع التشييد في السودان.

Contents

List of Tables

List of Figures

Common Acronyms

CSOW	change on project scope of work
SWM	Scope of Works Management
CRSOWM	Creating A Scope of works Management Plan
CRS	Collect Requirements from all stakeholders
DSOW	Define Scope of works
CWBS	Creating Proper Work Breakdown Structure
VSOW	Validate Scope of works
COSOW	Control Scope of works
CCSW	Causes of Change on Scope of Works

Chapter One

Introduction

Chapter One: Introduction

1.1 General:

In project management, stakeholders would be looking at the completion of the project and how it produces its intended outcomes. Thus before a project begins, it is necessary have clearly defined requirements for it acceptance.

Thus Scope of work is the core of construction projects, fulfilling the scope of work is the most important factor that Contributes to the effective performance in project management and the project's Success. It even takes precedence over the constraints of Time and cost and failure to manage and control this aspect of the project could be a principal reason why projects would fail (Knopp, 2011). The projects are managed looking at their success, and success is based on being on schedule, within budget, and time frame. Project scope management is the process required to ensure that the project includes all the work required and to complete the project successfully, (Ghosh, 2007). The scope of work is defined very early in the project planning and estimation phases. Fageha & Aibinu, (2013) stated that an incomplete scope definition in early stages of a project's life cycle is a common source of difficulty in project implementation process. Karl (2014) added that a well-defined scope sets expectations among the project stakeholders. Thus the scope definition helps the project manager assess the resources needed to implement the project and make realistic commitments.

This does not mean that the project scope has to be fixed; in fact changes to scope can happen during project lifecycle. Unexpected circumstances may arise during the project life cycle and would lead to scope change. Mochal (2004) stated that part of the work of the plan process is preparing for the inevitable fact that, once the project starts, the client will probably end up asking for more (or different) work than what was originally agreed to. This

is why scope-change management is used. Hence the project Scope can change for a number of reasons including internal factors (stakeholder requires insight into a problem), or external factors (government regulations, market conditions). Even the most small changes can cause unexpected problematic situation to the project. However, there has to be an overall control over project scope. The control does not necessarily mean preventing changes. On the contrary, if changes are needed in order to fulfil current requirements that are more actual than the original requirements, those changes must be implemented (Nguyen, 2010). Controlling and managing scope change is critical to the success of any project, as scope changes can significantly impact the cost, schedule, risks and quality of the entire effort (Suchan, 2007). But without change control, the project scope becomes a moving target and the project at risk of missing one or more of project success factors. The ability to manage and control change, particularly that of project scope could be a key to reaching goals and a typical performance indicator for a project manager (Qi Hao-2008) .

1.2 Research problem:

Project Scope Change has a high potential for occurrence in the construction industry due to the complicated feature of projects; the effect of change on project scope of work (CSOW) is very tangible in the project success.

So identifying the impact of CSOW in construction projects has been a topic of discussion and debate, especially those changes that delay contractors and disrupt productivity.

When changes are introduced prior, during or after construction work has been executed, the synergistic effects of these changes can dramatically affect project performance.

Being affected by the instability of economic, legislation, and the mismanagement of projects, the construction industry in Sudan has real challenges to keep project SOW without change during the project lifecycle.

1.3 Research questions:

- What are the causes for project scope change?
- What is the impact of changing project scope on project success?
- What are the effects of changing project scope on project constraints?
- What are the professional ways to control project scope change?

1.4 Research objectives:

The research objectives are:

- To identify ways adopted for identifying project scope of work by construction companies at Khartoum State.
- To identify and rank the causes for project scope change and to assess the frequency of their occurrence.
- To gauge the impact of causes of project scope change on project constraints
- To assess the application of change control process in the construction projects in Sudan.

1.5 Research layout:

The first chapter started by giving a brief introduction on Project scope of work then stating the research problem/ questions and finally outlining the research objective.

The second chapter present literature results achieved from previous studies and a collection of data /info about Project Constraints (Triple Constraint),Determination of project successes or failure considerations ,Project scope of work definition and management ,Causes and impacts of project scope change and change control processes .

The third chapter comprise from two main parts: the data collection tool and the selected sample.

The fourth chapter present the results analysis and discussion for the collected data.

The fifth chapter present conclusion and recommendation for this research and recommendation for further studies

Chapter Two

Literature Review &Previous Studies

Chapter Two: Literature Review and Previous studies

2.1 Project Constraints (Triple Constraint):

A constraint, in project management, is any restriction that defines a project's limitations; the scope, for example, is the limit of what the project is expected to accomplish. The three most significant project constraints are schedule(Time), cost and scope and sometimes known as the triple constraint or the project management triangle as shown in figure (1), which is a useful model to illustrate the consequences of change on the triple constraint to key project stakeholders. The triangle reflects the fact that the three constraints are interrelated and involve trade-offs – one side of the triangle cannot be changed without impacting the others. Project quality takes root in all three variables of the triple constraint and is affected by balancing the three factors. It may easily be argued that triple constraint affairs reside at the kernel of the most essential determinations surrounding projects

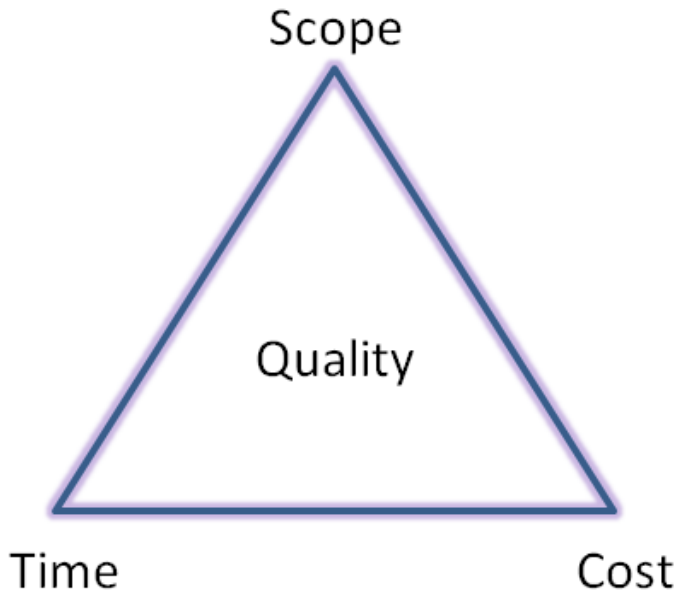


Figure 2-1The Triple Constraint

In the following there is a brief definition for the project constraint***:***

i. Scope:

The project's deliverables should be under focus for the scope criterion. Project scope is described in a *project charter* which commonly includes a description of the business needs that the project results are intended to address and a description of the results (i.e. a service or product description).

The scope criterion is not actually measurable. It is all about changes control and management. The most common technique for scope measurement is *Variance Analysis.* According to this technique, project performance measurements are used to assess the magnitude of variation of performance. Important aspects of project scope control include determining the cause of variance relative to the scope baseline and deciding whether corrective action is required. The scope baseline includes the scope statement and the Work Breakdown Structure (WBS) – this is a project's detailed list of activities.

ii. Time:

For the time criterion we have to focus on a project's schedule which specifies the timeline according to which those components will be delivered, including the final deadline for completion. A project schedule captures the planned dates for activities and milestones. The most common techniques for measuring the time criterion are:

- ✓ Performance Measurement
- ✓ Project Management Software (e.g. Prima Vera)
- ✓ Schedule Comparison Bar Charts

iii. Cost:

For the cost criterion we have to focus on a project's budget. The budgeting

Process focuses on determining the cost of project activities and establishing a cost baseline. The cost baseline is a record of the planned cost for a project or project phase. The most common techniques for measuring the cost criterion are:

- ✓ Earned Value Technique (EVT)
- ✓ Forecasting
- ✓ Trend analysis

iv. Quality:

For the quality criterion we have to focus on the quality of a project's performance and results. In terms of project success, we may also use the term "Quality Grade". Wideman (2000) defines the term quality grade as "A particular attribute of an item, product or service, which meets all minimum project requirements but which may be delivered according to a class ranging from 'utility' (purely functional) to 'world class' (equal to the best of the best)". The most common techniques for measuring the quality criterion are:

- ✓ Control Charts
- ✓ Histograms
- ✓ Pareto Charts
- ✓ Statistical sampling
- ✓ Scatter Diagrams
- ✓ Cause and Effect Diagrams

2.2 Determination of project successes or failure considerations:

Undoubtedly, to characterize a project as successful or a failed is not an easy task. One of the problems encountered is that the different parties involved in the project view success in a different way. The science of Project Management has not yet succeeded in reaching a consensus for the definition of project success. It is remarkable that the triple constraint is the sole

universally accepted mean of evaluating projects. In other words, we characterize a project as successful if it is finished on or before the establish schedules, if it gets completed within the budget guidelines and operates according to the customer specifications. What would one expect is a new model that could both accommodate the extra parameters and satisfy all groups concerned (managers, employees, customers, contractors, etc.). Next we present and analyze the concepts for project success by various authors.

Max Wideman (2000) determines project success as a multi-dimensional construct that inevitably means different things to different people. He believes that success is better expressed at the beginning of a project in terms of key and measurable criteria upon which the relative success or failure of the project may be judged.

He gives the following principle "The measure of project success, in terms of both process and product, must be defined at the beginning of the project as a basis for project management decision making and post-project evaluation. First and foremost, project success needs to be defined in terms of the acceptability of the project's deliverables, for example scope, quality, relevance, effectiveness, and so forth; secondly in terms of its processes, for example time, cost, and so forth. For Max Wideman the project evaluation has four dimensions, namely: product scope, quality grade, time-to-produce and total cost at completion. He underlines the importance of the product success to the overall success of the project.

James P. Lewis in *Project Planning scheduling & Control: a hands-on guide to bringing projects in on time and on budget* (2000) states that "The only truly successful project is the one that delivers what is supposed to, gets results, and meets *stakeholder expectations*." In this definition of project success we underline the phrase "stakeholder expectations". Lewis and many

writers as we are going to see next take into account the satisfaction of the project stakeholders as well as the unique way that each and every of them understands the term "success".

For Lewis there are four criteria for measuring project success. These are

Performance, Cost, Time and Scope. The first has to do with technical and functional performance requirements, the second with the labor and material cost needed to accomplish a task, the third with the time required for the project to be completed and last, the scope, that is the magnitude or size of the work. These are actually the four constraints for measuring project success established by the PMI.

Pinto & Rouhiainen (2001) as well as Kerzner (2001) add a new criterion to the triple constraint concerning the customer's satisfaction/acceptance. This is very important because this criterion turns the eyes of the company outside the organization and towards the customer. Furthermore, it enhances the specific role of the marketplace in a successful project.

Verzuh in *The fast forward MBA in project management* (2004) agrees that the golden triangle is enough to define success. Except from time and cost parameters he mentions high quality. Verzuh links quality with the outcome of the project that must have two components: functionality (what the project is supposed to do) and performance (how well the functionality works). However, Verzuh realizes that delivering a project on time, on budget and with high quality does not mean that it will necessarily be successful. The reason according to the writer is the deferent views and perceptions of success from the project stakeholders. He then refers to stakeholders' satisfaction but without suggesting the use of a new criterion or ways to measure the rate of that satisfaction as well as the need of that type of information. He clearly states: "successful projects have to meet all

stakeholders' expectations" and finally proposes agreement among the project team, customer and management on the project goals as a factor for project success.

2.3 Project Scope of work definition and management :

Project scope is the part of project planning that involves determining and documenting a list of specific project goals, deliverables, features, functions, tasks, deadlines, and ultimately costs.

In other words, it is what needs to be achieved and the work that must be done to deliver a project.

Project management institution (PMBOK Guide Fifth Ed) mentioned that the project scope management includes the processes required to ensure that the project includes all the work required, and only the work required, to complete the project successfully. Managing the project scope is primarily concerned with defining and controlling what is and is not included in the project, and also mentioned that there are five processes to manage scope of work which include the following:

1. Plan Scope Management:

   Is the process of creating a scope management plan that documents how the project scope will be defined, validated, and controlled. The key benefit of this process is that it provides guidance and direction on how scope will be managed throughout the project.

2. Collect Requirements:

   The process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives, The key benefit of this process is that it provides the basis for defining and managing the project scope and there are many tools and technique used to collect requirement like Interviews, Focus groups, Facilitated workshops,

Group creativity techniques ,Group decision-making Techniques, Questionnaires and surveys, Observations, Prototypes ,Benchmarking, Context diagrams and Document analysis ,The project's success is directly influenced by active stakeholder involvement in the discovery and decomposition of needs into requirements and by the care taken in determining, documenting, and managing the requirements of the product, service, or result of the project. Requirements include conditions or capabilities that are to be met by the project or present in the product, service, or result to satisfy an agreement or other formally imposed specification. Requirements include the quantified and documented needs and expectations of the sponsor, customer, and other stakeholders. These requirements need to be elicited, analyzed, and recorded in enough detail.

Requirements are classified to many categories included but not limited to:

- Business requirements, which describe the higher-level needs of the organization as a whole, such as the business issues or opportunities, and reasons why a project has been undertaken.
- Stakeholder requirements, which describe needs of a stakeholder or stakeholder group.
- Solution requirements, which describe features, functions, and characteristics of the product, service, or result that will meet the business and stakeholder requirements.
- Transition requirements describe temporary capabilities, such as data conversion and training requirements, needed to transition from the current "as-is" state to the future "to-be" state.
- Project requirements, which describe the actions, processes, or other conditions the project needs to meet.

- Quality requirements, which capture any condition or criteria needed to validate the successful completion of a project deliverable or fulfilment of other project requirements. To be included in the scope baseline and to be measured once project execution begins. Requirements become the foundation of the WBS. Cost, schedule, quality planning, and sometimes procurement are all based upon these requirements.

3. Define Scope:

   The process of developing a detailed description of the project and product, the key benefit of this process is that it describes the project, service, or result boundaries by defining which of the requirements collected will be included in and excluded from the project scope.

   Since all of the requirements identified in Collect Requirements may not be included in the project, the Define Scope process selects the final project requirements from the requirements documentation delivered during the Collect Requirements process. It then develops a detailed description of the project and product, service, or result. The preparation of a detailed project scope statement is critical to project success and builds upon the major deliverables, assumptions, and constraints that are documented during project initiation.

4. Create WBS:

   Create WBS is the process of subdividing project deliverables and project work into smaller, more manageable components. The key benefit of this process is that it provides a structured vision of what has to be delivered. The WBS is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. The WBS organizes and defines the total scope of the project, and represents the work specified in the current approved project scope statement.

The planned work is contained within the lowest level of WBS components, which are called work packages. A work package can be used to group the activities where work is scheduled and estimated, monitored, and controlled. In the context of the WBS, work refers to work products or deliverables that are the result of activity and not to the activity itself.

5. Validate Scope:

   Validate Scope is the process of formalizing acceptance of the completed project deliverables. The key benefit of this process is that it brings objectivity to the acceptance process and increases the chance of final product, service, or result acceptance by validating each deliverable.

   The verified deliverables obtained from the Control Quality process are reviewed with the customer or sponsor to ensure that they are completed satisfactorily and have received formal acceptance of the deliverables by the customer or sponsor.

   The Validate Scope process differs from the Control Quality process in that the former is primarily concerned with acceptance of the deliverables, while quality control is primarily concerned with correctness of the deliverables and meeting the quality requirements specified for the deliverables. Control Quality is generally performed before Validate Scope, although the two processes may be performed in parallel.

6. Control Scope:

   Control Scope is the process of monitoring the status of the project and product scope and managing changes to the scope baseline. The key benefit of this process is that it allows the scope baseline to be maintained throughout the project.

Controlling the project scope ensures all requested changes and recommended corrective or preventive actions are processed through the Perform Integrated Change Control process. Control Scope is also used to manage the actual changes when they occur and is integrated with the other control processes. The uncontrolled expansion to product or project scope without adjustments to time, cost, and resources is referred to as scope creep. Change is inevitable; therefore some type of change control process is mandatory for every project.

2.4 Causes for Scope Change:

Changes in construction projects are very common and likely to occur from different sources, by various causes, at any stage of a project, unfortunately in Sudan Decisions are made every day in construction processes based on incomplete information, assumptions and the personal experience of the construction professionals. For that reasons Project changes and/or adjustments are inevitable as they are a fact-of-life at all stages of a project's life cycle. Managing changes effectively is crucial to the success of a construction project.

2.4.1 Categories for the Causes of Change:

Changes, which are singularly or collectively administratively documented in the form of change orders, occur for many reasons on construction projects. On the surface, each change to a construction contract is unique when compared to all other changes on the same project. However, most all changes share some common characteristics and can be classified in common categories. In construction, primarily on design-bid- build projects, the causes of changes have been classified into five categories. According to two US

Federal government studies (National Research Council 1986), one by the US Army Corps of Engineers and the other by the US Navy, the categories into which the primary causes for changes fall are:

- design deficiencies
- criteria changes
- unforeseen conditions, including differing site conditions
- changes in scope directed by the owner
- other categories

The following is further description of each of the change causing categories:

- Design deficiencies :Also known as designer errors and omissions; these changes relate to plans that are incomplete or contain errors that aren't found until the construction contractor finds them well after the construction phase of the project has started. With most construction contracts, in which the contractor bids on designs that are completed prior to contract award, the owner is liable for the designer's errors and omissions. Designer deficiencies are changes that are the result of faulty or confusing aspects of construction designs and specifications, attributable to the designer, which are not discovered until the contractor begins working towards building what is shown on paper. As opposed to the other types of change, design deficiencies are often the result of ineffective quality control in the design process, and are controllable. Designer errors may go beyond the development of the project designs and specifications. There are a few theories on why this type of change is most common among construction projects. The most prevalent theory posits that the financial pressures owners are under to complete projects as soon as possible are transferred to the designer, who is asked to complete the design within an unreasonable timeframe that encourages error through haste. According to the studies by the

US Army Corps of Engineers and US Navy, design deficiencies account for nearly 40% of all construction changes on a design-bid-build project, more than any other category of change.

- Criteria changes: For most projects, government owners will refer to a specific version of their design or construction standards. It happens sometimes, however, that government owners who have well established written standards for design and construction choose to revise those standards after the construction has been awarded based on a previous version. Criteria changes can also be found on projects with private owners who also have well established design and construction standards, or private owners whose projects are subject to government design and construction standard changes.
- Differing Site or Unforeseen conditions: A differing site or unforeseen condition occurs when latent site conditions of a construction project are uncovered after the contract between the contractor and the owner has been executed, and was not previously anticipated or included in the design documents. Differing site conditions are worth making note of only if the contractor experiences an increased cost and/or delay. Common examples of differing site conditions occur when a contractor performs earth excavation and uncovers objects or soil types that were previously unforeseen, and require extraordinary measures to accommodate. These extraordinary measures can easily cost the contractor additional money and/or time above that for which they were originally contracted.
- Changes in scope directed by the owner: Although changes in scope directed by the owner are not the most frequent changes, they are the most controllable on the part of the owner. These changes represent those in which the customer, the owner, chooses to make changes to the final product after the design has been completed and the contractor

has been hired. According to Bramble & Callahan (2000), 'most construction contracts give the owner the right to make changes within the general scope of the contract without breaching or invalidating the contract' (Bramble and Callahan 2000, 3-22, footnote 100). The American Institute of Architects (AIA) has in fact developed a set of contract documents that are frequently used in US-based general construction. According to the AIA's General Conditions of the Contractor for Construction, the owner is given the right to make changes…'after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or for a minor change in the Work…' (AIA 1997, Article 7).

- Other changes: There are many changes that do not easily fit into any of the four categories already mentioned. US military studies include the following types of changes in their 'Other' category like Contract Options, Value engineering ,Administrative ,Accounting, Deficiency in Government furnished property ,Unresolved claims, New laws, regulations, codes , Currency reevaluation ,Suspension of work and Other.

2.4.2 List of the Causes for Change:

Causes of scope change in Construction projects included but not limited to the following:

2.4.2.1 Poorly Defined Scope of work (Requirements):

A well-defined project scope enables successful completion of a project within the planned time, budget, and quality parameters. In the field of project management, scope definition is carried out during the pre-planning phase, which is a period that requires investing a substantial amount of time and resources in activities leading to the final investment decision. This effort is

proven to be an effective way of increasing the chances of project success while significantly decreasing the risks that could arise during project implementation. It is also prudent, especially in public infrastructure projects, to include the time for this pre-planning in the overall duration of a project. This can also assist in managing public delivery time expectations and thus, in some sense, even positively influence project success.

Project pre-planning efforts focus on defining a project in enough detail to increase the visibility of what needs to be accomplished to meet the requirements of the beneficiaries of project deliverables. At the same time, care is taken not to spend too much time on defining the project, since quick service or product delivery is required by the end-users. It is believed that projects that have a well-defined scope during pre-planning are less likely to encounter surprises such as scope creep, schedule slippages, cost overruns, and poor quality of deliverables. By defining a project thoroughly, all likely risks are identified and proactive action can then be taken either to reduce the likelihood of the occurrence, or to reduce the impact, of the risk if it occurs.

2.4.2.2 Change in stakeholder requirements:

Construction projects attract interest from various stakeholders who express needs and expectations about the project. These are often in conflict with each other and it is unlikely that all of them can be fulfilled. The stakeholder management process involves evaluating the needs and expectations of stakeholders in relation to the main objectives of the project. An important basis for this evaluation is stakeholder analysis. The approach is based upon established theory, knowledge of stakeholder management and empirical data. The analysis consists of a stakeholder impact index to determine the nature and impact of stakeholder influence, the probability of stakeholders exercising their influence and each stakeholder's position in relation to the

project—are they proponents or opponents? The analysis of the stakeholder impact index can help project managers to formalize a stakeholder management process.

2.4.2.3 Regulatory Change:

When new regulations or legislation is introduced this can result in a change to project scope or requirements, to make sure that the project scope remains compliant with the new regulations or legislation requirements.

changing in regulations or legislation can happen at any point in the project life cycle so the earlier forecasting and getting aware about them will decreasing their negative impact on the project ,Unfortunately sometime A legislative or regulatory change might lead to the close the entire project.

2.4.2.4 Change in project Sponsor:

The project sponsor is an individual (often a manager or executive) with overall accountability for the project. He or she is primarily concerned with ensuring that the project delivers the agreed upon business benefits and acts as the representative of the organization, playing a vital leadership role through a series of areas on the project.

A project sponsor is typically responsible for initiating, ensuring, approving, and establishing a series of key aspects in relation to the project, which can be summed up under categories of vision, governance, and value/benefits realization.

New project sponsor will bring new ideas, and refer the vital leadership role of project sponsor and his wide responsibility and authority, potentiality of changing in project scope will getting rise .

2.4.2.5 Business Strategy Change (Business needs changed)

A change in direction of business strategies could result changes to the scope or requirements on project. This could happen at any point in the project life cycle, business strategies are often under constant review for competitive threats, even if the organization has published a three- or five-year strategic plan. Ultimately, a change to the strategy could result in a major change on project scope to be compliant with the new business strategies.

2.4.2.6 Updated Technology:

Refer to the rapid globalization especially on the construction industry ,new building technology may existing after the planning process or during the execution of project and this new technology of course will affect on scope of work for project in the positive way

2.4.2.7 Unbalance between budget availability and real cost for the project:

Matching between real project cost and available budget may become unbalance for the several reasons and this will affect on the scope of work as explain below:

1. Changing in budget availability for the project:

Budget availability for the project may change due to the political and economic instability of country and this will affect directly to the scope of work because the client has to reduce the work according to the new available Budget.

2. Increasing the real cost of project:

Cost of project may increase due to the economic instability of country, improper cost estimation (plan) and inflation and this also will lead to reduce the scope of work if the budget is constant.

2.4.2.8 Lack of knowledge about construction industry:

In Sudan some owner who has no a well knowledge about construction industry he will not have ability to reading out drawings and imagine the final picture of his house ,so during the implementation of project he will arise new requirements according to his imagination which he fail to reflect it during the design phase .

2.4.2.9 Change of design:

The construction industry involves different stages that are followed for the projects to be executed. Designing is one among the stages involved. What is expected to be executed is what had been designed but things may be different from this expectation.

The construction industry in general is accompanied by the changes of different aspects in it in such a way some are inevitable. There are different factors that lead to change of design during construction stage some of which lead to cause problems to the overall performance of construction project . Changes in design are frequent in many projects in which construction starts before the design is finalized. Such changes affect the project in various ways depending on the timing of the change.

As put forward, construction projects are more difficult to manage because of uncertainty factors inherent in the projects. The uncertainty of the projects is reflected in the difficulty of obtaining design information during the design process. As a result, most projects end up with high amounts of design changes during construction stage.

Changes of design in construction can be caused by various sources at different stages of the work. The cause of change may originate from external or internal issues that may occur during the development phases of project i.e. from basic design to construction

The following are internal factors that lead to change of design during construction stage categorized according to the parties of project

- Owners Factors :
- ✓ The owner instruction to modify a design.
- ✓ Owner's change of schedule due to financial problem.
- ✓ Incorrect information given by owner.
- ✓ Owner fails to make decisions or review document at the right time.
- ✓ Additions of new works/scopes (not part of original scope)
- ✓ Omission of works/scopes (reduction on original scopes).
- ✓ Unclear initial design brief.
- Design consultant's factors:
- ✓ The unrealistic period to design.
- ✓ The failure of a consultant to provide adequate and clear information in the tender documents; errors and omission of consultants.
- ✓ The consultants who are not familiar with the regulations and construction permits.
- ✓ The presence of conflicts between contract documents
- ✓ The low consultant fee and poor coordination of design team members.
- ✓ Lack of consultant's knowledge of available material and equipment.
- ✓ The underestimate of the cost of the project.
- ✓ Unclear and inadequate details in drawings.
- ✓ Production of Structural detail does not match Architectural detail.
- contractor's factors :
- ✓ The unrealistic construction's schedule.

- ✓ The changes initiated by contractors to improve quality and constructability.
- ✓ Lack of contractor's involvement in design.
- ✓ Contractor's desired profitability, cost escalation & financial problem.
- ✓ Poor project management and planning by contractor.
- ✓ Contractor's change requests for easier operations, higher income, within the allowable limits for the project.
- ✓ Lack of coordination among members with design team.
- ✓ Rectify construction mistakes.

- Managing consultant's factors :
  - ✓ Failure of communication amongst parties involved within a construction project.
  - ✓ Improper supervision of the work executed by contractor.
  - ✓ Lack of precise decisions.
  - ✓ Insufficient careful checking and correct planning documents
  - ✓ Lack of rapid decisions

The following are the external factors that lead to change of design during construction stage:

- Environmental Factors :
  - ✓ Changes of weather conditions.
  - ✓ Occurrence of natural disaster such as flood, earthquake.
  - ✓ Insufficient information on geological conditions.
  - ✓ Unforeseen ground conditions.
- Third party's factors :
  - ✓ The complaint from neighbourhood.
  - ✓ The request made by end user.
  - ✓ The request from investor who came while construction has started.

- ✓ The request from regulatory bodies.

- Political and economic factors:
  - ✓ The changes in policies and regulations.
  - ✓ Inflation and price fluctuation.
  - ✓ Unavailability/shortage of materials.
  - ✓ Change of market demand of the intended use of Project

2.4.2.10 Errors and omissions in design:

When asked to define "design error," not all disciplines in the construction process agree on a common definition. Depending on which discipline you address, the owner, the designer or the contractor there will be a common understanding surrounded by varied conclusions, "a mistake." From the basic definitions of "design" and "error" we conclude that a design error is a deviation from a drawing or specification, also including omissions and ambiguities. It is the seriousness of this error that must be considered to determine its consequences on the overall outcome of the project, one of the most important challenges facing management today is controlling the too frequent cost and schedule overruns that effect the construction industry.

2.5 Change Control Process:

Change is something that is inevitable even with the most successful projects. So what's critical is that to know how to manage change and ensure the project remains on track and ultimately successful.

The most important thing that the projects managers must check it before the starting any project is the availability of a change control process.

"Change Control" is a formal process. It is set up to enable project teams to modify the scope of the project using specified controls and policies. Change can include anything that would impact the project constraints (Time, cost,

and Scope) all of which can impact quality. Most of the time, it's scope that impacts the other constraints. Here's a simple process that must be followed to ensure changes are properly managed.

2.5.1 Define the Change Request:

Change Control is the process. A Change Request is the documentation used to request the actual change. Whoever owns the actual request needs to explain it in such a way that the team understands it well enough to define it. This should be done through appropriate documentation (whatever the project team or company expects). It can be as simple as an email or as complex as a formal document.

When defining the change, it's necessary to have in hand the actual request with all supporting statements. This should include:

- Actual Request: Statement of the need. This should outline clearly the change items for the project team to analyze.
- Reason for the Request: Customer impacts if the request cannot be completed or if considerable time passes before the request can be completed
- Expected Completion: The requester should provide an expected due date for the item. This doesn't mean the change will be completed by this date. It's simply meant to provide more details for the team to analyze when defining options.
- Expected Value: This should explain why the request is needed. It can either be something as simple as "better customer experience" or "revised calculation provides more accurate data" in relation to a report.

2.5.2 Submit and Review the Change Request :

Once the Change Request is documented, it's submitted to the project team. Here again, the process varies from the simple (a phone call or email) to the formal (a memo or meeting). Unless the request is very simple, it is prefer to review the change with the full team. That meeting provides the proper venue for the request to be reviewed, and all members have a chance to ask questions and help make decisions.

There should be two portions to reviewing the Change Request: the formal presentation or meeting and the project team's review and discussion of impacts. Within the change control process there should be an expected turnaround time for these. Discussions with the customer should include setting expectations regarding response time, or at least when the team will provide feedback.

2.5.3 Define Options and Create Response Document:

Once the team has reviewed the Change Request, options should be defined. There should be a minimum of two. When providing the document response, always provide each option with some of the data points below as well as a team recommendation, which represents its view of the best choice. The client may not always go along, but it can help them make a decision.

The response should include:

- Option Number and Name
- Proposed Solution: This should include how to respond to the change request. It can be anything from a technical direction and justification as to why this particular approach is being put forward.
- Proposed Timeline: The client always needs to know how long something is going to take. The estimated timeline is a piece of

information they will leverage when making a choice based on the options the team presents.

- Impacts to the Project: This is an essential part of the response. If changes are small, there may be no impacts. But most changes will have some sort of impact. The scope change can impact the timeline, the budget and therefore the quality of the product. This area should minimally explain the cost of the changes, the impact on the timeline and potential quality results. There may also be resource impacts. The team may either have to get additional people or may define a need for existing resources to add or remove time on the project. All of these items should be defined clearly to enable the customer's decision making.
- Expiration Date for Proposed Changes: This sets a timeframe for the client to respond to the proposed solution and cost/time impacts. If the client goes outside of the set window, there could be additional impacts to the project. That aside, setting an expiration date provides urgency to the process.

2.5.3 Final Decision and Approval:

The client should provide a timely response. If the Change Control Response document expires, it should be re-evaluated once the client provides feedback. If too much development has occurred to sustain the change, then that needs to be stated. If the delayed response has resulted in other impacts, this must be clarified to the client. It's also possible that an expired response could lead to an additional review and proposal.

Whatever decision results from all this it needs to be officially approved. So the Change Control process must include a list of sponsors, stakeholders and key decision makers who can approve both the process and the decision.

Chapter Three

RESEARCH METHODOLOGY

Chapter Three: RESEARCH METHODOLOGY

3.1 Introduction:

Some queries concerning preliminary thoughts stated here arose from observation during the execution of real construction project in Sudan.
An attempt was made to arrange these in a form of questions to be answered through the research problem investigation process.

To allow this a descriptive approach was adopted where survey was conducted to study the actual process as it is practical and happens in its setting.
A questionnaire was then chosen as the main tool to be devised for data collection

3.2 Sample size and configuration:

The target research population is the complete count of engineers, contractors, and owners with different position held, whom work at construction organizations and construction sites and such projects in the construction field.

A sample size of 100 Respondents' was targeted and randomly selected. 80 copies were distributed and 65 were returned back.

5 copies were excluded an 60 copies were considered as a final sample size The academic qualification of the participants was as illustrated in Figure (3.1) ,which show that half of the participants holds Bachelor Degree, while (40%) hold a master degree , (8%)hold PhD Degree and (2 %)hold Diploma .

Whereas, (37%) of the participants were Owners while about third (33%) were classified as Contractors, a quarter (25%) were a consultant and the rest

(5%) were academic staff (refer to Figure 3.2). Of all Participants, (51.7%) were described as public sector organization while (48.3 %) were private (see figure 3.3).

Furthermore, it was found that about (79 %) of participants were civil engineer specialist. While (18 %) were architect specialist and the rest (3 %) were others (see figure 3.4).

When asked to identify their experience, it was found that (31.7 %) of have more than 15 years of experience in the field. in addition to(35 %) have 10-15 years experience while(26.7%) of the Respondents' have an experience between 5-10 years. only (6.7 %) have less than 5 years experience(refer to figure 3.5).

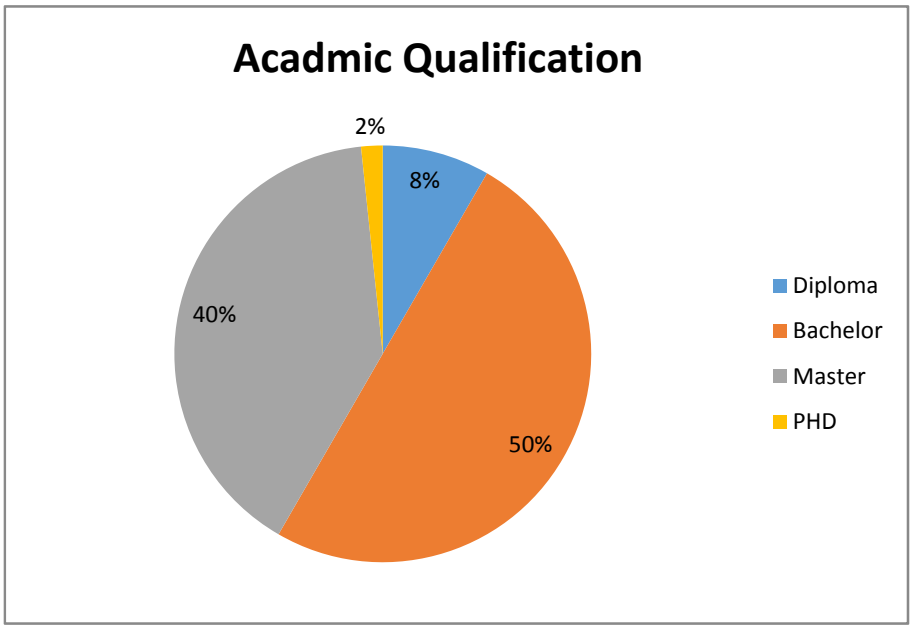


Figure 3-3-1: Participants' Academic Qualification

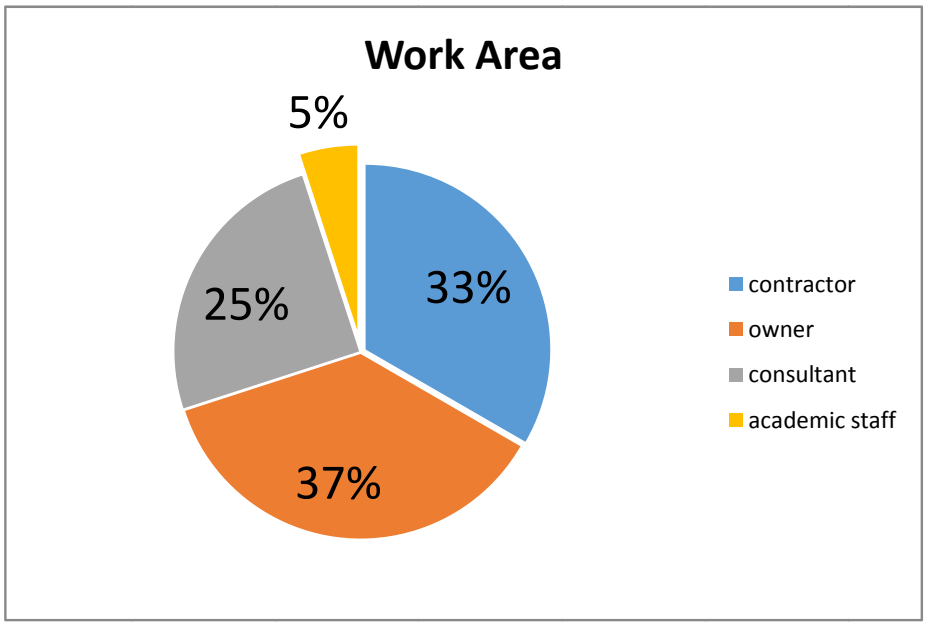


Figure 3-3-2: Work Area Distribution

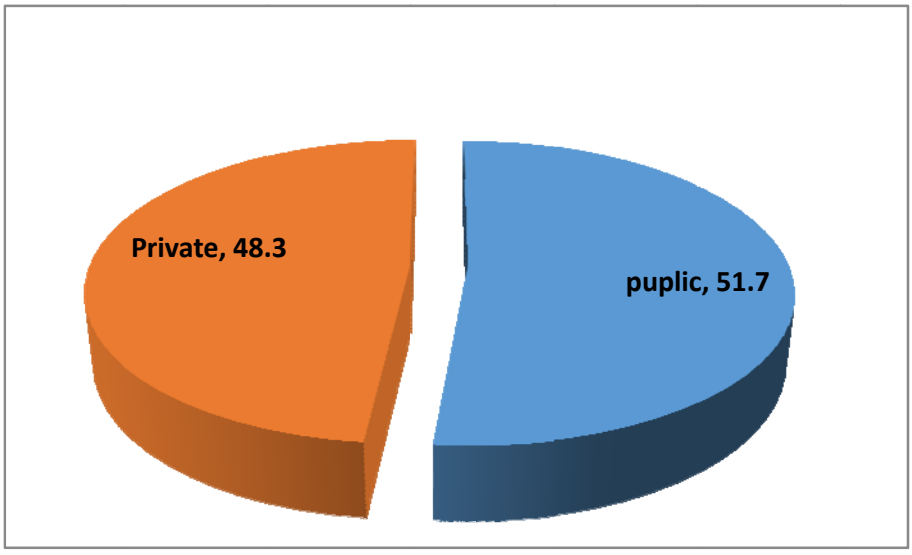


Figure 3-3-3: Work Sector

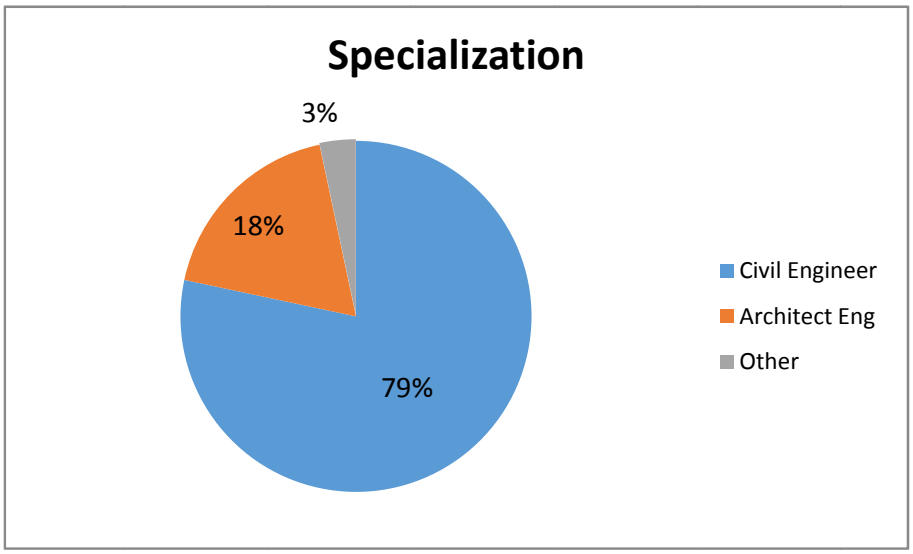


Figure 3-3-4: Specialization

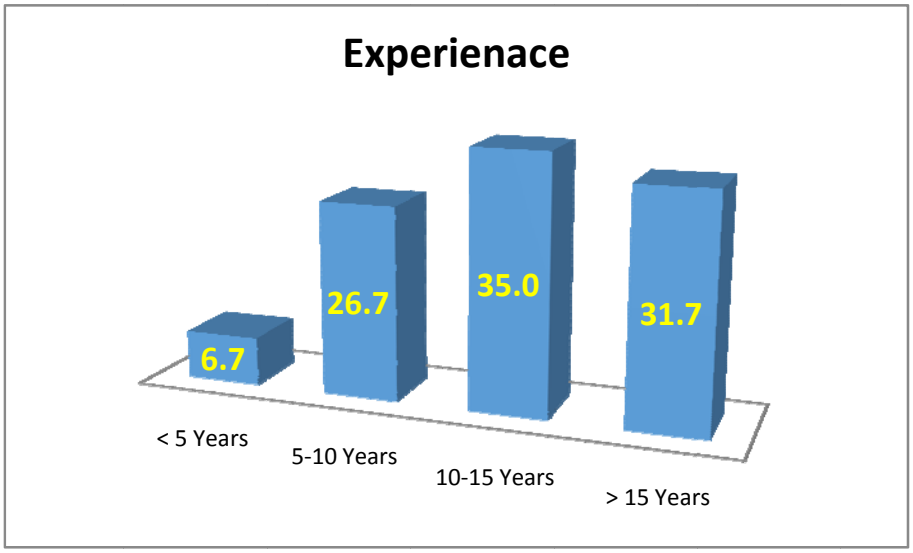


Figure 3-3-5: Experience

3.3 Questionnaire Design:

A questionnaire was then chosen as the main tool to be devised for data collection ,Questionnaires were distributed to different parties in the construction industry including Owners, Consultants and Contractor ,The questionnaire comprised of Five Sections, and the statements and question were extracted and concluded from literature review and pervious study detailed as follow :

Section One: General Information about the participants

Section Two: Scope of Works Management in Sudan

Section Three: Causes Of Change on Scope of Works in construction projects in Sudan

Section Four: Measurement of The Impact Of change Of Scope of works On Project constraints (Time, Cost and Quality)

Section Five: Measurement Of Change Control Process In The construction Projects in Sudan

The questionnaire was analyzed using statistical analysis by Microsoft Office Excel to obtain opinions about Causes for change in scope of work and their impact in the constraints of project and how this change are managed in construction projects. The questionnaire was responded in ranking answers reflecting the audient opinion such as Always, Often, Sometime, Rare and Never.

3.4 Questionnaire Piloting:

Five copies from questionnaire were distributed to the selected participants to check the validity of the data collection tool and to test the questions are properly written, well understood and complete and in line with the research objective and queries.

From the feedback came from participants whom filled the piloting questionnaires, there were number of modification did in the questionnaire as follow:

- ✓ adding Arabic language in parallel to the English language
- ✓ removing the introduction of questionnaire in the first page
- ✓ modification of the main questions in the section Two and Four
- ✓ remove two sub question in section five

Chapter Four

Results Analysis and Discussion

Chapter Four: Results Analysis and Discussion

4.1 Sample configuration:

The sample comprised area is distributed as owners (37%), contractor (33%), consultant (25%) and Academic staff (5%), the distribution of sample focused on the owner because he is the one mostly affected by the change of scope of work.

The substantial majority of participants (79 %) were civil engineers and the experience of those who took part in the survey was variable: 93.3 % confirmed that their experience was over than 5 yrs, while 66.7% have experience more than 10 yrs that means high confident result.

4.2 Analysis Procedure:

In the analysis process a weighted average calculations was performed where in the 5-points Likert Scale. Respondents' answers were given weight (Always=5, Often=4, Sometime =3, Rare=2, Never=1). The frequencies of Respondents' feedback against each question were complied then an important index was calculated for each statement follow the presented equation:

II = ∑(Weight *Number of vote)/Total number of questionnaires

The range of important index categorized as shown in Table 4-1.

Table 4-1 Importace Index range

Option	Never	Rare	Sometime	Often	Always
weight	1	2	3	4	5
Range	0-1.5	1.6-2.5	2.6-3.5	3.6-4.5	4.6-5

4.3 Scope of Works Management (SWM):

This part was concerned with the procedural aspects and steps applied for scope of works management during the execution of construction projects in Sudan , Six steps were mentioned in questionnaire and they were namely :

1. Creating A Scope of works Management Plan (CRSOWM).

2. Collect Requirements from all stakeholders (CRS)

3. Define Scope of works by developing a detailed description of the projects (DSOW).

4. Creating Proper Work Breakdown Structure (CWBS)

5. Validate Scope of works (formalizing acceptance of the completed project Activities) (VSOW)

6. Control Scope of works (monitoring the status of the project scope of works and managing changes to the scope of works baseline) (COSOW)

Respondents were asked to give an account on frequently they usually apply each of the listed steps and were given Five options (always, often, sometime, rarely and never) to describe their actual practice (refer to section-2 in the questionnaire -Appendix B) .The result shown in figure 4-1 represent the calculated II for each step.

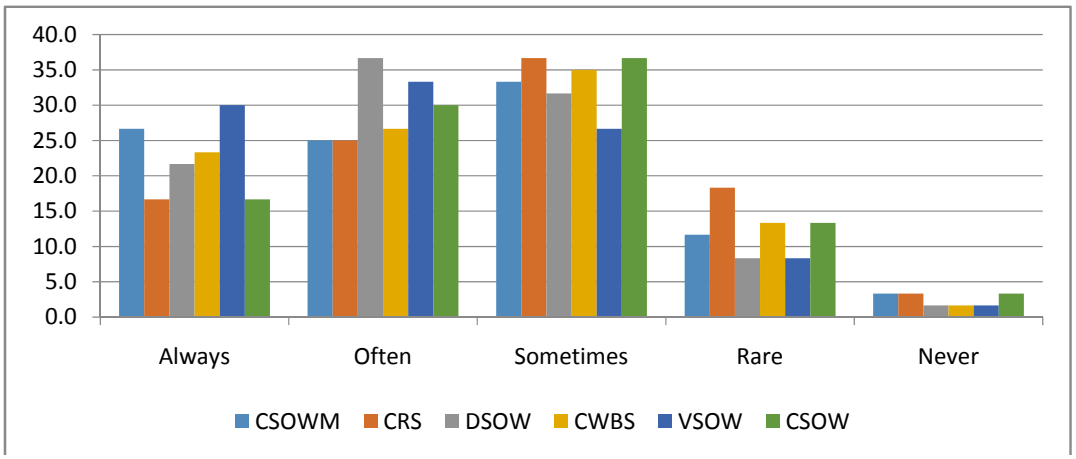


Figure 4-1 Frequency of use of Steps for SOWM

The practice in Sudan regarding this aspect is summarized in Table 4-1which shows the ranking of steps and it shows that the "Validate Scope of works " (formalizing acceptance of the completed project Activities) has 3.82 II which is the highest ranking value and this reflect the nature of owners whom they have highest parentage in the Respondents' .

Table 4-2: Determination the steps are applied for scope of works management

Determination the steps are applied for scope of works management		
a	Validate Scope of works (formalizing acceptance of the completed project Activities)	3.8
b	Define Scope of works by developing a detailed description of the projects	3.7
c	Creating A Scope of works Management Plan	3.6
d	Creating Proper Work Breakdown Structure (WBS)	3.6
e	Control Scope of works (monitoring the status of the project scope of works and managing changes to the scope of works baseline)	3.4
f	Collect Requirements from all stakeholders	3.3

Refer to Table 4-1 and 4-2 the steps categorised as shown in Table 4.3

Table 4-3 Categories of SWM steps

Probabilityof applied	Never	Rare	Sometime	Often	Always
NO of Steps for SWM	-	-	e,f	a,b,c,d	-

From the results, all steps of SWM were applied in different frequency, steps number e & f applied sometime and steps number a,b,c and d were applied Often .

No steps were categorised under frequency (Always) and this reflect that the SWM need more attention and practice.

4.4 Causes of Change on Scope of Works (CCSW):

To determine the most frequent cause of change of scope of work in Sudan, respondents were provided with a 10-items list containing possible causes and were asked to state their opinion. The aim was to rank accordingly these causes based on their relative importance. As such they were asked to indicate how frequently (Always, Often, Sometime, And Rarely and Never) each of the causes may occur .Table 4-4 presents the result.

Table 4-4 Causes of change on scope of works

Causes Of Change On Scope Of Works		
No	**Cause**	**Ranking**
1	Unbalance between budget availability and real cost for the project	4.2
2	Change in stakeholder requirements	3.8
3	Poorly defined Scope of works(requirements)	3.7
4	Lack of knowledge about construction industry from some owners	3.6
5	Change of design	3.6
6	Regulatory Change (New government regulations)	3.1
7	Business Strategy Change (Business needs changed)	3.0
8	Errors and omissions in design	3.0
9	Change in project Sponsor	3.0
10	Updated Technology	2.5

It was Cleary evident that the Unbalance between budget availability and real cost for the project in Sudan which lead to the Unbalance between budget availability and real cost for the project has the highest value of ranking (occurring Often) and also reflect the Fear from using the last technology in construction industry in Sudan which lead to make the cause called Updated Technology has the lowest value of ranking (occurring rarely).

Refer to Table 4-1 and Table 4-4 the ten causes of change in scope of work were categorised as shown in Table 4-5.

Table 4-5 Categorized causes of scope of work change

Probability of Occurrence	Never	Rare	Sometime	Often	Always
Causes NO	-	10	6,7,8,9	1,2,3,4,5	

Table 4-5 summarized that the ten causes happen with different frequency:

- ✓ all of them are causes
- ✓ Cause no. 10 rarely happens
- ✓ None of them happen always
- ✓ Causes no 6,7,8,9 happen sometime
- ✓ Causes no 1, 2,3,4,5 happen often and this is where the Implementer have to pay attention.

4.5 Measuring the Impact of Causes of Scope of works Change on Project constraints:

This section was about assessing The Impact of Causes Of Scope of works Change On Project constraints (Time ,Cost ,Quality) .

The Calculation of Important index has been established for causes against every project constraints' as detailed in Tables (4-6, 4-7, 4-8).

Table 4-6 the affect of causes in project Time

Causes Vs Time	Ranking
Unbalance between budget availability and real cost for the project	3.1
Change in stakeholder requirements	3.0
Regulatory Change (New government regulations)	3.0
Change of design	2.9
Change in project Sponsor	2.8
Poorly defined Scope of works(requirements)	2.6
Lack of knowledge about construction industry from some owners	2.5
Errors and omissions in design	2.5
Updated Technology	2.4
Business Strategy Change (Business needs changed)	3.4

Table 4-6 reflects the cause of SOW change called Unbalance between budget availability and real cost for the project has the highest value of ranking which means has the highest impact in the project time because the procedure for get addition finance to complete the Project take a lot of time and the non availability of the provision sum budget in the most project in Sudan support the mentioned cause to be a significant cause influences the project time .in addition to that calculation of estimation cost for certain project become real challenge due the instability of economic and inflation in Sudan .

The second significant cause was the Change in stakeholder requirements which reflect the real problem faces the most construction industry in Sudan. Which is the uncertainty of owner requirements led to multi amendment in the work (additional work, rework, removing some executed work etc) and this of course have a real impact in the project Time.

Table 4-7 the affect of causes in project cost

Causes VS Cost	Ranking
Lack of knowledge about construction industry from some owners	3.5
Unbalance between budget availability and real cost for the project	3.0
Poorly defined Scope of works(requirements)	3.1
Change in project Sponsor	3.0
Business Strategy Change (Business needs changed)	3.0
Updated Technology	2.6
Change of design	2.6
Regulatory Change (New government regulations)	2.5
Change in stakeholder requirements	2.4
Errors and omissions in design	2.2

Table 4-7 illustrate clearly the lack of knowledge about construction industry from some owners in Sudan. During the execution phase, the owner discovers the executed works not matches to his perspective. However, it is not the contractor's errors rather than owner's knowledge and abilities not quite enough to give him complete picture for the final deliverable.

Table 4-8 the affect of causes in the quality of project

Causes VS Quality	Ranking
Errors and omissions in design	2.7
Updated Technology	2.7
Change of design	2.6
Lack of knowledge about construction industry from some owners	2.4
Unbalance between budget availability and real cost for the project	2.3
Poorly defined Scope of works(requirements)	2.1
Change in stakeholder requirements	1.9
Regulatory Change (New government regulations)	1.9
Change in project Sponsor	1.7
Business Strategy Change (Business needs changed)	1.6

Table 4-8 shows that the cause of errors and omissions in design has the highest impact on the project quality. Furthermore, the second two causes affected the projects was the updated technology and change of design. These three causes are the most causes affected in the quality of project in Sudan.

It refers that the failure of the most projects in Sudan due to the short period of preparation, unclear and incomplete owner's requirements, led to design errors and changes in the initiation phase in the projects.

Moreover, the financial planning such as business strategy and project sponsor for the projects is not significantly affect the quality of project than the other causes occur due to short preparation in initiation phase.

From Tables (4-6,4-7,4-8) finding that the highest ranking value in the Table 4-7 which shows the impact of causes on project cost ,based on this result the most affected project constraint by scope change is the cost followed by the time and the quality.

4.6 Measurement of Change Control Process in the construction Projects In Sudan:

This section included four steps for Change Control Process In The construction Projects and these steps are namely :

1. Define change request (CR) (include four sub steps).

2. CR and its impact is reviewed and discussed by the all members of the project team.

3. Strategy for implementing CR (include sex sub steps)

4. CR Approved by all stakeholders (key decision makers)

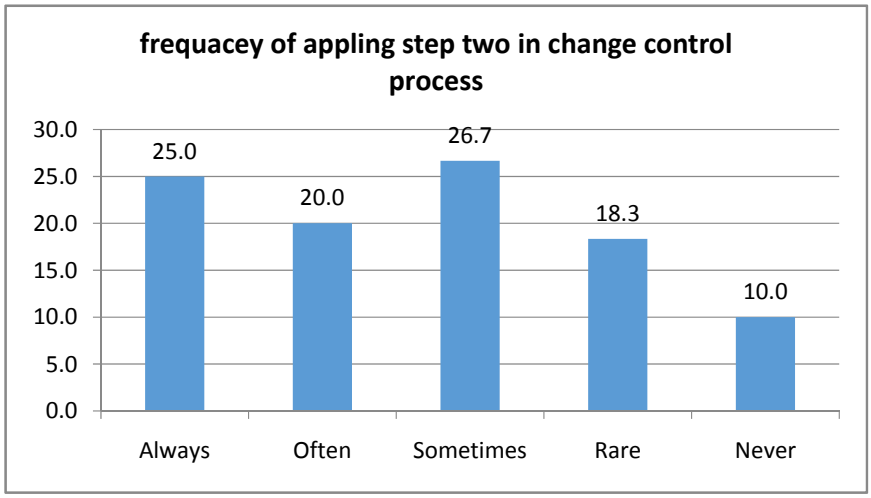
Calculation of the importance index for the application of each sub steps for the one and three has been established and shows in tables (4-9, 4-10)

Frequency of Appling steps two and four shows in figure (4-2, 4-3)

Table 4-9 Steps for the Define of Change Request

Steps for the Define of Change Request	
information	Ranking
CR involve Expected Value of change	3.83
CR involves a statement of the reason(s) for request.	3.77
A clear outline of the change items on the project	3.52
CR involve Expected Completion date	3.32

Table 4-9 shows that the most information shall be involved in change request was the value of change followed by the a statement of the reason(s) for request, this result reflect how far the realists of sample because the first two type of information are the basic information for the decision maker to make a decision to accept or reject the change request.



*4-2 shows the freqancy of appling the step Two (*CR and its impact is reviewed and discussed by the all members of the project team*)*

Figure (4-2) shows the frequency of Appling the step Two (CR and its impact is reviewed and discussed by the all members of the project team) , unfortunately the option sometimes has the highest frequency (26.7 %) and the option never has frequency value 10 % (near to 50 % from highest value of frequency), which reflect the problems occurred in the projects in Sudan due to unshared all stakeholders in the change request approval Procedure

Table 4-10 strategy steps for implementing CR

Strategy for implementing CR	
Sub Steps	Ranking
Impact of CR on project cost	3.97
Impact of CR on project time	3.80
Timeline for Appling CR	3.67
Impact of CR on project scope	3.57
Impact of CR on project quality	3.20
Expiration Date for Proposed Changes	2.60

Table (4-10) shows that the most important two constraints affected by CR (project cost and time) for the owners have the highest value of ranking, unfortunately the Expiration Date for Proposed Changes has the lowest value of ranking and this reflect why there are some change request in projects in Sudan have impact because they were implemented after the Expiration Date for Proposed Changes validity.

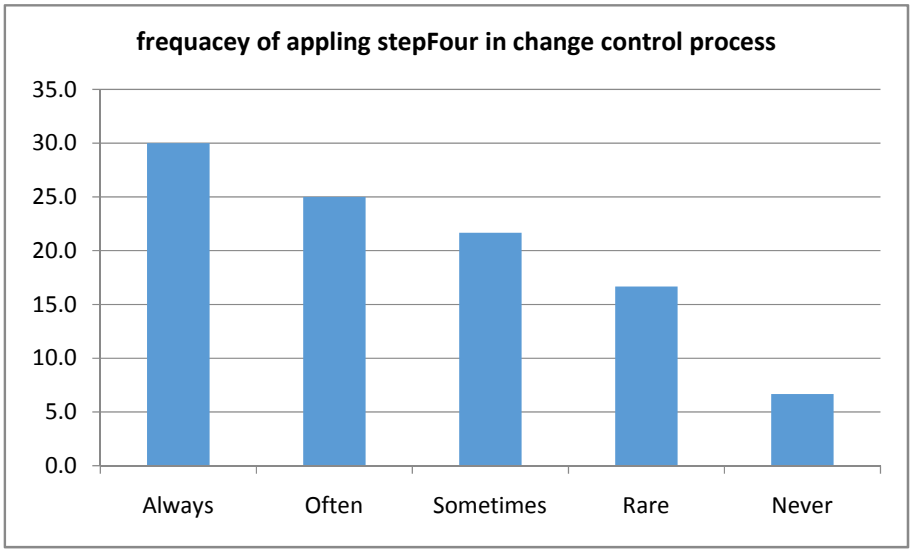


Figure 4-3 shows the freqancy of appling the step Four (CR Approved by all stakeholders)

Figure (4-3) shows the frequency of approval for CR from all stakeholders (key decision makers), although the option always has the highest value of ranking but the value was just 30 % which indicate that in the most projects in Sudan the all stakeholders were not shared in the approval of CR which lead to the conflict of interest between stakeholders and may rich to the failure of projects

Chapter Five

Conclusion &Recommendation

Chapter Five: Conclusion and recommendation

5.1 Introduction:

In this chapter, the main findings with regard to the research questions are summarized and general conclusions based on the findings of the studies presented in this thesis are described. This chapter concludes with recommendations to identify ways adopted for identifying Project scope of work properly.To identify and rank the causes for project scope change and to assess the frequency of their occurrence. To rank causes of project scope change against each project constraints based on their impact on them and to measure the application of change control process in the construction projects in Sudan

5.2 Conclusions:

The conclusion illustrated the objectives of this study. The objectives were achieved successfully based on the result can be divided into four categories:

5.2.1 Conclusion related to the identify ways adopted for identifying Project scope of work by construction companies in Khartoum State:

It was found that all the six steps of identifying project scope work properly were applied in construction industry in Sudan were:

1. Creating a Scope of works Management Plan (CSOWM).

2. Collect Requirements from all stakeholders (CRS)

3. Define Scope of works by developing a detailed description of the projects (DSOW)

4. Creating Proper Work Breakdown Structure (CWBS)

5. Validate Scope of works (formalizing acceptance of the completed project Activities)(VSOW)

6. Control Scope of works (monitoring the status of the project scope of works and managing changes to the scope of works baseline) (CSOW)

5.2.2 Conclusion related to identify and rank the causes for project scope change and to assess the frequency of their occurrence:

It was found that the causes of scope of work change in Sudan are Unbalance between budget availability and real cost for the project, Change in stakeholder requirements, Poorly defined Scope of works (requirements), Lack of knowledge about construction industry from some owners, Change of design, Regulatory Change (New government regulations), Business Strategy Change (Business needs changed), Errors and omissions in design, Change in project Sponsor and Updated Technology.

Unbalance between budget availability and real cost for the project is the most causes happened in Sudan and has significant affect in project constraints.

5.2.3 Conclusion related to the Measuring the Impact of Causes of Scope of works Change on Project constraints:

From the results, it concluded that the most causes affected in Project time is Unbalance between budget availability and real cost for the project and in Project cost is Lack of knowledge about construction industry from some owners and finally in Project Quality is Errors and omissions in design

5.2.4 Conclusion related to the Measurement of Change Control Process In The construction Projects in Sudan:

From the data collected with the questionnaires and the statistic analysis were preformed, it was found that:

- Most of change requests and its impact were not get reviewed and discussed by the all members of the project team.
- in the most projects all stakeholders (key decision makers) were not share in approving the change request
- Expiration Dates for Proposed Changes were not mentioned in most of the change request proposal.

5.3 Recommendation:

This research found out many causes for scope of work change and their impact in project constraints according to the data collected with the questionnaires, and the statistic analysis and ranking were preformed .To avoid this cause many Precautionary steps must be done, this steps included but not limited to :

1. Insure all stakeholder are involving in define scope of work by collecting their requirements.
2. Taking enough time in Designing stage because it is one among the stages of construction involved. What is expected to be executed is what had been designed. In addition, to avoid errors and omissions in design the thing that has great impact in project quality.
3. Create proper work breakdown structure (WBS) for project to increase the accuracy of cost estimation for the construction of the project
4. Secure enough budgets with provision sum before the initiation phase of the project and then perform peer reviewed before starting the project to minimize the risk of cost overrun.
5. Use the up to-date technology for designing and 3D view or BIM software to present the final design feature clear for the owners specially individual owners to confirm the unity of the target deliverables between owners and contractor.

6. Insure that the change control steps are applied during the construction phase to minimize the risk of scope change.

5.4 Recommendation for further study:

It would be recommended for future researchers to:

- Collect more data and analyse it using the same methodology and questionnaire in this research for the project parties individually (sample from one area only), to compare the behaviour and action for the scope of work change between the Owner, Contractor and Consultant.
- The impact of project constraints changes in the project successes and find formula to determine the effect of changing in any project constraints in the others.
- Disputes and Arbitrations arising between owners and contractors due to lack of documentation and formalising of scope change, and to determine the rules of consultant in prevention these Disputes and Arbitrations to occur.

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Appendixes:

Appendix A
Initial version of questionnaire

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Sudan University of Science and Technology
College of graduate Studies – Civil Engineering

A questionnaire on the Impact of Project Scope Change on the Success of Construction Projects in Sudan

The aim of this study is to identify the causes for project scope change and to assess their impact on projects constraints (time, cost, and quality). It also seeks to determine the approach for controlling change in the scope of work with professional way to reduce its negative impact in the project successes in sudan .

- Your participation in this survey is valuable in attaining the objectives of this study.
- This study is conducted under the academic supervision of Sudan University of science and technology.
- The information provided will be treated confidentially and for academic purpose only.

For any queries, please do not hesitate to contact on TEL: 0123494608

Section One (General Information)

1- Name (Optional): …….

2- Organization (Optional): ……..

3- Current Position Title: …….

4- Academic qualification :

☐ Diploma ☐ Bachelor ☐ Master ☐ PhD

☐ Other (please specify)……

5- Work Area :

☐ Contractor ☐ Owner ☐ Consultant ☐ Academic staff

☐ Other (please specify)…….

6- Work Sector:

☐ Public ☐ Private ☐ other (please specify)…….

7- Specialization:

☐ Civil Eng ☐ Architect Eng ☐ other (please specify)……

8- Experience :

☐ Less than 5 years ☐ 5-10 years ☐ 10-15 years ☐ More than 15 years

9- Number of projects you participated in executed:

☐ Less than 5 Projects ☐ 5-10 Projects

☐ 10-15 Projects ☐ More than 15 Projects

10- how many projects were changing in their scope of work ?

☐ Less than 5 Projects ☐ 5-10 Projects

☐ 10-15 Projects ☐ More than 15 Projects

Section Two: Scope Of Work Management:

In your opinion, what are the steps are Appling in scope of work Management in the construction projects in sudan?

No	Factor	Always	Often	Sometimes	Rare	Never
1	Creating A Scope Management Plan					
2	Collect Requirements from all stakeholders					
3	Define Scope by developing a detailed description of the project					
4	Creating Proper Work Breakdown Structure (WBS)					
5	Validate Scope(formalizing acceptance of the completed project deliverables)					
6	Control Scope (monitoring the status of the project and product scope and managing changes to the scope baseline)					

Section Three: Causes Of Change On Scope Of Work

In your opinion, what are the factors causing change on scope of work in construction projects in sudan ?

No	Factor	Always	Often	Sometimes	Rare	Never
1	Poorly Defined Scope of work(requirements)					
2	Change in stakeholder requirements					
3	Regulatory Change (New government regulations)					
4	Change in project Sponsor					
5	Business Strategy Change (Business needs changed)					
6	Updated Technology					
7	Change of design					
8	Unbalance between budget availability and real cost for the project					
9	Lack of knowledge about construction industry					
10	Errors and omissions in design					
	Others :					
11						
12						

Section Four: Measuring The Impact Of Causes Of Scope Change On Project (Time, Cost And Quality)

What is your assessment for the impact of the listed causes of scope change on projects (time, cost, quality)?

4	3	2	1
%(100-76) Impact	%(75-51) Impact	%(50-26) Impact	%(25-0) Impact

No	Factor	Time	Cost	Quality
1	Poorly Defined Scope of work(requirements)			
2	Change in stakeholder requirements			
3	Regulatory Change (New government regulations)			
4	Change in project Sponsor			
5	Business Strategy Change (Business needs changed)			
6	Updated Technology			
7	Change of design			
8	Unbalance between budget availability and real cost for the project			
9	Lack of knowledge about construction industry			
10	Errors and omissions in design			
	Others :			
11				
12				

Section Five: Measurement Of Change Control Process In The Projects In Sudan

According to your assessment, please indicate the frequent of applied each steps for change control process in projects in sudan .

No	Factor	Always	Often	Sometimes	Rare	Never
1	**Define change request (CR) :**					
1.1	A clear outline of the change items on the project					
1.2	CR involves a statement of the reason(s) for request.					
1.3	CR involve Expected Completion date					
1.4	CR involve Expected Value					
2	**CR and its impact is reviewed and discussed by the all members of the project team**					
3	**Strategy for implementing CR include :**					
3.1	minimum two option for implement CR					
3.2	Timeline for Appling CR					
3.3	Impact of CR on project time					
	Impact of CR on project cost					
	Impact of CR on project quality					
	Impact of CR on project scope					
3.4	Expiration Date for Proposed Changes					
4	CR Approved by all stakeholders (key decision makers)					

Appendix B
Final version of questionnaire

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

Sudan University of Science and Technology

College of graduate Studies – Civil Engineering

A questionnaire on the Impact of Project Scope Change on the Success of Construction Projects in Sudan

إستبيان لدراسة تاثير تغيير نطاق الأعمال على نجاح مشاريع التشييد في السودان

- Your participation in this survey is valuable in attaining the objectives of this study.
  - مشاركتكم في هذه الإستبيان لها الاثرالفعال في تحقيق اهداف البحث
- This study is conducted under the academic supervision of Sudan University of science and technology.
  - هذه الدراسة هي جزء من بحث مقدم تحت إشراف جامعة السودان للعلوم والتكنولوجيا
- The information provided will be treated confidentially and for academic purpose only.
  - المعلومات التي سترد ستعامل بسرية كاملة وتستخدم لإغراض البحث العلمي فقط

For any queries, please do not hesitate to contact on TEL: 0123494608

للمزيد من المعلومات او الإستفسارات يمكن التواصل عبر الرقم

0123494608:

Section One (General Information) (القطاع الأول :معلومات عامه)

1- Name (Optional): …….

2- Organization (Optional): ……..

3- Current Position Title: …….

4- Academic qualification(المؤهلات العلميه) :

☐ Diploma ☐ Bachelor☐ Master ☐ PhD

☐ Other (please specify)……

5- Work Area(التصنيف) :

☐ Contractor ☐ Owner☐ Consultant ☐ A academic staff

☐ Other (please specify)…….

6- Work Sector(قطاع العمل):

☐ Public ☐ Private ☐ other (please specify)…….

7- Specialization(التخصص):

☐ Civil Eng ☐ Architect Eng ☐other (please specify)……

8- Experience(سنوات الخبرة) :

☐ Less than 5 years☐ 5-10 years☐ 10-15 years☐ More than 15 years

9- Number of projects you participated in executed?

(عدد المشاريع التي شاركتة في تنفيذها)

☐ Less than 5 Projects ☐ 5-10 Projects

☐ 10-15 Projects ☐ More than 15 Projects

10- how many projects were changing in their scope of works ?

(عدد المشاريع التي تم تغير نطاق الأعمال فيها)

☐ Less than 5 Projects ☐ 5-10 Projects

☐ 10-15 Projects ☐ More than 15 Projects

Section Two: Scope Of Works Management(القطاع الثانى :إدارة نطاق الأعمال):

During the execution of construction projects in Sudan which of these steps are applied for scope of works management ?

خلال تنفيذ مشاريع التشييد في السودان ماهي اي من الخطوات التالية التي يتم تطبيقها لإدارة نطاق الأعمال ؟

No	Factor	Always دائماً	Often غالباً	Sometimes احياناً	Rare نادراً	Never لايحدث
1	Creating A Scope of works Management Plan إعداد خطة لإدارة نطاق الأعمال					
2	Collect Requirements from all stakeholders جمع المتطلبات من جميع اصحاب المصلحة					
3	Define Scope of works by developing a detailed description of the projects تعريف نطاق الأعمال من خلال تطوير وصف تفصيلي للمشاريع					
4	Creating Proper Work Breakdown Structure (WBS) إنشاء هيكل لتقسيم الأعمال بصورة دقيقه					
5	Validate Scope of works (formalizing acceptance of the completed project Activities) التحقق من نطاق الأعمال (الحصول على موافقة رسمية للنشاطات المكتملة بالمشروع)					
6	Control Scope of works (monitoring the status of the project scope of works and managing changes to the scope of works baseline) التحكم في نطاق الأعمال (من خلال مراقبة وضع نطاق أعمال المشروع وإدارة التغيرات لنطاق الأعمال الأساسي)					

Section Three: Causes Of Change On Scope Of Works :

القطاع الثالث :أسباب التغيير في نطاق الأعمال

In your opinion, what are the factors causing change in scope of works in construction projects in Sudan ?

برأيك ، ما هي العوامل المسببة للتغيير في نطاق الأعمال في مشاريع البناء في السودان؟

No	Factor	Always دائماً	Often غالباً	Sometimes احياناً	Rare نادراً	Never لايحدث
1	Poorly defined Scope of works(requirements) ضعف التعريف بنطاق الأعمال (المتطلبات)					
2	Change in stakeholder requirements تغيير في متطابات اصحاب المصلحة					
3	Regulatory Change (New government regulations) التغييرات التنظيمية(لوائح حكومية جدديدة)					
4	Change in project Sponsor تغيير راعي المشروع					
5	Business Strategy Change (Business needs changed) تغيير إسترتيجية العمل (تغيير إحتياجات العمل)					
6	Updated Technology التطور في التكنولوجيا					
7	Change of design تغيير في التصميم					
8	Unbalance between budget availability and real cost for the project عدم الاتزان بين توافر الميزانية والتكلفة الحقيقية للمشروع					
9	Lack of knowledge about construction industry from some owners نقص المعرفة عن مشاريع التشييد من بعض الملاك					
10	Errors and omissions in design الأخطاء والسهو في التصميم					
	Others : اخرى					
11						
12						

Section Four: Measuring The Impact Of Causes Of Scope of works Change On Project constraints (Time, Cost And Quality)

القطاع الرابع : قياس تاثيير اسباب تغيير نطاق الأعمال على مقيدات المشروع (الزمن ,التكلفة والجودة)

What is your assessment for the impact of the listed causes of scope of works change on project constraints (time, cost, quality)?

ماهو تقييمك لأثر اسباب تغيير نطاق الأعمال على مقيدات المشروع (الزمن ,التكلفة والجودة) ؟

4	3	2	1
%(100-76) Impact	%(75-51) Impact	%(50-26) Impact	%(25-0) Impact

No	Factor	Time الزمن	Cost التكلفة	Quality الجودة
1	Poorly defined Scope of works(requirements) ضعف التعريف بنطاق الأعمال (المتطلبات)			
2	Change in stakeholder requirements تغيير في متطابات اصحاب المصلحة			
3	Regulatory Change (New government regulations) التغييرات التنظيمية(لوائح حكومية جدديدة)			
4	Change in project Sponsor تغيير راعي المشروع			
5	Business Strategy Change (Business needs changed) تغيير إسترتيجية العمل (تغيير إحتياجات العمل)			
6	Updated Technology التطور في التكنولوجيا			
7	Change of design تغيير في التصميم			
8	Unbalance between budget availability and real cost for the project عدم الاتزان بين توافر الميزانية والتكلفة الحقيقية للمشروع			
9	Lack of knowledge about construction industry from some owners نقص المعرفة عن مشاريع التشييد من بعض الملاك			
10	Errors and omissions in design الأخطاء والسهو في التصميم			
	Others : اخرى			
11				
12				

Section Five: Measurement Of Change Control Process In The construction Projects In Sudan

القطاع الخامس :قياس عملية التحكم في التغيير في مشاريع التشييد في السودان ؟

According to your assessment, please indicate the frequently of application of each of the following steps for the change control process in projects in Sudan .

وفقًا لتقييمك ، يرجى الإشارة إلى التطبيق المتكرر لكل خطوة من الخطوات التالية لعملية مراقبة التغيير في مشاريع البناء في السودان

No	Factor	Always دائماً	Often غالباً	Sometimes احياناً	Rare نادراً	Never لايحدث
1	**Define change request (CR) :**					
1.1	A clear outline of the change items on the project ملخص واضح للعناصر المتغيرة في المشروع					
1.2	CR involves a statement of the reason(s) for request. طلب التغيير يحتوي على بيان لأسباب الطلب					
1.3	CR involve Expected Completion date طلب التغيير يحتوي على زمن الإنتهاء					
1.4	CR involve Expected Value of change طلب التغيير يحتوي على القيمة المتوقعة للتغير					
2	CR and its impact is reviewed and discussed by the all members of the project team طلب التغير وتاثيراته على المشروع يتم مناقشتها من قبل جميع فريق العمل بالمشروع					
3	**Strategy for implementing CR include : إسترتيجية تنفيذ طلب التغير تحتوي على**					
3.1	Timeline for Appling CR جدول زمني للتطبيق					
3.2	Impact of CR on project time تاثير طلب التغييرعلى زمن المشروع					
3.3	Impact of CR on project cost تاثير طلب التغييرعلى تكلفة المشروع					
3.4	Impact of CR on project quality تاثير طلب التغييرعلى جودة المشروع					
3.5	Impact of CR on project scope تاثير طلب التغييرعلى نطاق المشروع					
3.6	Expiration Date for Proposed Changes تاريخ إنتهاء لصلاحية التغيير المقترح					
4	CR Approved by all stakeholders (key decision makers) الموافقة على طلب التغيير من قبل جميع اصحاب المصلحة (صانعي القرار الأساسين)					

مع جزيل الشكر والعرفان