

MANAGEMENT OF CHANGES IN LARGE CONSTRUCTION PROJECTS

Case Studies, International Experience, Issues
and Risks

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To my family

*Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise
before defeat.*

Sun Tzu

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I would like to thank Luis Rocha, my manager in Edificadora Luz & Alves Lda between 1998 and 2004, for his patience mentoring me as a new graduate, showing that questioning the obvious and ourselves is what may allow one to find solutions and achieve what at first may seem impossible.

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RESUMO

A gestão inadequada de alterações contratuais foi identificada pela academia e pelos profissionais de gestão de projectos como uma das principais razões de fracasso de projectos. A mesma causa foi identificada pela indústria da construção há décadas e ainda hoje continua a ser um problema.

Embora a causa esteja identificada, a maioria do conhecimento na área de gestão de alterações contratuais em projectos de construção está focada na avaliação e categorização das causas de alterações e nos impactos das alterações, e não nas razões porque é que os processos de gestão de alterações contratuais em projectos de construção sejam inadequados.

Esta dissertação apresenta o estado da arte de como standards de gestão de projectos, e condições de contractos de construção utilizados internacionalmente, preconizam que a gestão de alterações contratuais deve ser efectuada, seguido de casos de estudo de projectos em que o autor participou durante os seus vinte anos de experiência profissional em Portugal, Roménia, Médio Oriente e Vietnam, com ênfase nos processos de gestão de alterações contratuais, como a indústria da construção adapta os best practices, nas causas e impactos dessas adaptações, e como o autor abordou, ou tentou abordar esses problemas.

O autor discute razões e apresenta o que considera serem causas das falhas dos processos de gestão de alterações contratuais, que contribuem para disputas contratuais, fracasso de projectos e danos nas relações entre Donos de Obra, Gestores de Projecto e Empreiteiros.

PALAVRAS-CHAVE: Projectos de Construção, Gestão de Alterações, Mitigação de Disputas, Alterações de Contrato, Estudo de Casos.

ABSTRACT

Inadequate Change Management has been identified by project management academics and professionals as one of the leading causes of project failure. This has also been recognized decades ago by the construction industry and it is still a major issue today.

Although this cause of project failure is identified, most knowledge found in the area of management of changes in construction projects is on assessing and classifying causes of changes and on impacts of changes on projects, not on why change management processes used in construction projects are inadequate.

This paper presents the current state of the art on how project management best practices standards and international standard construction contract forms foresee that management of changes is performed. Presents relevant case studies from the author twenty years' professional experience and practice in Portugal, Romania, Middle East and Vietnam, focusing on how the industry alters and adapts change management processes, the impact of such alterations, and how the author has tackled, or attempted to tackle such issues; discusses, provides reasoning and presents what the author considers to be root causes for change management processes failure, which increase the likelihood of disputes, projects' failure, and damage to the relationships between Employers, Contract Administrators and Contractors.

KEYWORDS: Construction Projects, Change Management, Dispute Avoidance, Variations, Case Studies.

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SYMBOLS, ACRONYMS AND ABBREVIATIONS

APM – Association for project management

BMS – Building management system

BoQ – Bill of Quantities

COBA – Consultores de Engenharia e Ambiente

Contractor – means the person(s) named as contractor under a construction contract, the entity performing the construction for the Employer

CDC – Centers for Disease Control and Prevention

CEMP – Construction Environmental Management Plan

Construction Extension – Construction Extension to the PMBoK Guide

DAB – Dispute Adjudication Board

EIA - Environmental Impact Assessment

EL&A – Edificadora Luz & Alves Lda

Employer – means the person named as employer under a construction contract, the entity for whom the construction is being done, who has ordered the construction project and who will pay for it

Engineer – means the person appointed by the Employer to act as Engineer for the purposes of the construction contract; its responsibilities include technical supervision and construction management.

FEUP – Faculdade de Engenharia da Universidade do Porto

FIDIC – Fédération Internationale Des Ingénieurs-Conseils

FIDIC Red Book 1999 – Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, First Edition

FIDIC Red Book 2017 – Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, Second Edition

ISPA – Instrument for Structural Policies for Pre-Accession

KPMG – international auditors Klynveld Peat Marwick Goerdeler

MAME – MonteAdriano Middle East

MDB – Multilateral Development Banks

MoSCoW – prioritization method Must, Should, Could, Would/Won't

MPA – Major Project Association

MU – monetary units

Owner – the same as Employer, in the sense of the entity awarding and paying for the construction

PMBoK – Project Management Body of Knowledge Guide 6th Edition

PMI – Project Management Institute

PRINCE2 – PRojects IN Controlled Environments

1

INTRODUCTION

1.1. FOREWORD

The author completed his civil engineering 5-year licentiate degree in 1998, at Lisbon University's Instituto Superior Técnico. About to complete twenty years of professional career, his experience includes managing construction and engineering projects from medium to megaprojects, in several continents, with multicultural and diverse teams members, diverse client types, performing roles on both Contractor and Employer/Engineer sides.

At this stage of his career, the author has the time to put down in paper some of the knowledge accumulated through experience and practice which he hopes students and professionals within the construction industry find of value.

This period preparing this dissertation allowed the author to give consideration to his experiences, project successes and failures, collect his thoughts on specific project management knowledge areas and issues, which have and will continue to impact the industry.

This dissertation is compliant with Article 3º of FEUP's regulation [1] which establishes the conditions to grant the qualification of Master to holders of a 5-year licentiate degree.

1.2. JUSTIFICATION OF THE REPORT

Having initiated his professional career in 1998, the author managed a diverse portfolio of projects, ranging from large scale developments, infrastructures schemes, shopping centres, hotels, residential, high rises, from inception and planning, construction to final handover, representing Employers; Consultants and Contractors, throughout several countries.

In twenty years of career, the author progressed from a Site Manager (Director de Obra) for a Portuguese tier two contractor to a Project Director / Deputy General Manager of sizable international projects in the Middle East for a contractor, and from there to a Projects Director for an international engineering and construction consultant in the world's top 80, delivering diverse projects in a multitude of countries. Throughout his career the author learned from his managers and people who he managed, learned from project successes and also when things went wrong.

One of the areas which the construction industry and project management professionals have identified as critical to project's success or failure is the management of project changes. This dissertation intends to give back some of the author's experience on this subject, by providing the insight of real situations, through presenting case studies on change control issues, how these were addressed, its impacts and lessons learned.

Project Management as a science, and its application, have made a major contribution to the improvement of management of construction projects and industry; project management standards take into consideration best practices which, in the author's opinion, are best developed by bottom-up challenging and continuously confronting the status quo.

This report does not intend to be an academic essay or to make an exhaustive analysis of this subject; it intends to be a light reading document, accessible to students and professionals, challenging the readers to think of why a decision was taken, or why something was done in the way presented, if it makes sense for them or if they would see opportunities to do better.

The author hopes that this report transmits the passion he has for engineering and construction project management and that it will be able to inspire others to continuously develop their knowledge on the subject.

1.3. METHODOLOGY

Case studies are valuable by providing the opportunity to ask "how" or "why" questions regarding specific situations and/or events. On the issue of processes to manage changes in construction projects, the author concludes that known best practices are often not applied.

This dissertation starts by presenting the state of the art regarding project change management and change control, and how international standard construction contract forms are compatible or not with such best practices. It confirms that inadequate change management processes are, directly or indirectly, one of the main causes of project failure.

The author then presents different case studies on change management and change control; each case study includes a summary of the project, the contract conditions relevant to management of changes, project specific issues and what was the approach to address such issues, concluding by identifying lessons learned and causes of why the construction industry does not follow best practices.

1.4. OBJECTIVES

The main objective of this report is to transmit knowledge gained while applying project management tools and skills in specific management of changes issues, identify possible causes of why change management processes in the construction industry are inadequate and contribute to construction projects' failure and present recommendations to Employers when adjusting the change management processes of standard contract forms or when developing their own.

Based on his experience and as presented in the case studies, regarding causes for inadequacy of change management processes applied in large construction projects, the author was able to find similarities in different regions and types of project, suggesting that this evaluation is particularly relevant and does contribute to transmit knowledge.

1.5. STRUCTURE

This report is organized in six chapters as follows:

- Chapter 1 – Introduction;
- Chapter 2 – Management of Changes Under Project Management Standards, presenting how changes are to be managed under the guidance of the latest editions of the PMBoK and PRINCE2, two of the most applied project management guidelines;
- Chapter 3 – Management of Changes in Construction Projects, presenting management of changes under the latest Construction Extension to the PMBoK and also under the latest FIDIC Red Book issued in 2017, and comparing the management of changes process under the FIDIC Red Book with the processes foreseen by the PMBoK and PRINCE2;
- Chapter 4 – Case Studies on Change Management Processes in Large Construction Projects, presenting that the construction industry inadequate Change Management and Control is one of the main contributors for Project Failure and two case studies from the author’s experience in a Contractor, the first on successfully implementing an adequate change control process in a project in Romania and the second on severe impacts of inadequate Change Control Processes and misuse of power to vary in a project in the Sultanate of Oman;
- Chapter 5 – Case Studies on Performing Change Control in Large Construction Projects, presenting important skills and knowledge for professionals managing and controlling changes, followed by two case studies from projects in the Middle East, the first on the impacts of omitting the Engineer’s power to vary and determine and the second on assessment of variations;
- Chapter 6 – Conclusions in which the author builds on the lessons learned from the case studies presented, and advances to what in his opinion are measures to avoid inadequacy of Change Management Processes, ending with suggestions for further research.

Each chapter is divided in sections, as presented in the table of contents.

1.6. AUTHOR’S PROFESSIONAL BACKGROUND

Following the completion of the civil engineering 5-year licentiate degree in 1998, the author joined Edificadora Luz & Alves Lda (EL&A), a tier two Portuguese contractor specialized residential developments. The author’s first position was as the sole site engineer on a 15 buildings, 169 apartment’s project in central Lisbon.

After successfully completing his first project with EL&A, the author moved to COBA – Consultores de Engenharia e Ambiente (COBA), Portugal’s leading engineering design consultant for infrastructures; during eleven months the author designed roads in COBA’s transportation department.

In the end of 2000, the author was invited to return to EL&A to share with a colleague the project management of what at the time was EL&A’s largest construction project, comprising of 384 apartments in Lisbon, 12 buildings, 24 shops and three levels of underground parking.

After that projects’ completion, the author successfully delivered two more residential projects in EL&A until leaving in early 2004.

From April 2004 to mid-2005 the author managed the Developer's Tenant Coordination Team of the largest outlet shopping centre in Europe, in the outskirts of Lisbon.

In mid-2005 the author attended training on Global Project Management where he was introduced to the Project Management Institute's (PMI) standard at the time, the Project Manager Body of Knowledge 3rd Edition.

During 2006, the author worked for a consortium of tier two Portuguese contractors joining efforts to bid internationally. This business development / commercial role took the author to the Middle East where he started gaining experience in FIDIC / International contract forms.

In January 2007 the author was invited by Engexpor, the leading Portuguese Project Management Consultant for shopping centres, to lead an ongoing project that was having several issues. 11 months later, 3 months of delay had been recovered and the shopping centre opened on time with 87% of the units operating at opening day.

In April 2008 the author was invited to join MonteAdriano Group and lead this tier one Portuguese contractor's technical department in their Romanian operation, the responsibilities including providing technical and contractual support to the five ongoing construction projects in Romania and to offers. In December 2009 the author moved to MonteAdriano Middle East (MAME) where he later became the project manager for the group's first project in Oman, and where by late 2010 he was nominated Deputy General Manager of MAME.

MAME's project concluded in March 2013, at the same time the author was invited to join the Artelia Group in Oman. Artelia is a leading French Engineering and Project Management Consultancy firm and within the top 80 engineering consultants worldwide. The author was hired to lead the group's largest international project awarded in 2013, a high profile military megaproject, requiring the author to report directly and regularly to high ranked military officers, government officials and to Artelia's headquarters management.

In mid-2015 Artelia invited the author to move to their Dubai subsidiary, to take the role of Projects Director, responsibilities included coordinating several projects, business development, supporting Project Directors/Project Managers on contractual issues and operations monitoring and control for the whole subsidiary.

By January 2017, the author moved to Artelia Vietnam where for seven months he developed commercial activities for infrastructures projects while coordinating the set-up of teams to manage 5 building projects, including high-rises and resorts. Since mid-2017 the author has supported Artelia Middle East on commercial activities and as an expert on project management and contractual / claims management on projects with ongoing issues.

2

MANAGEMENT OF CHANGES UNDER PROJECT MANAGEMENT STANDARDS

2.1. INTRODUCTION

This chapter provides an introduction to what are project changes and change management. The author takes guidance from the 2017 editions of internationally recognized project management guidelines, the Project Management Body of Knowledge Guide 6th Edition (PMBok) [2] and the Projects IN Controlled Environments methodology (PRINCE2) [3], and presents:

- Definitions of project changes and its common causes;
- Examples of less common changes experienced by the author;
- How project management standards, as are the PMBoK and PRINCE2, recommend project changes to be managed;
- Two examples of how different organizations have incorporated such best practices, and a change control process proposed by the author in a project managed by him.

2.2. WHAT CONSTITUTES A CHANGE AND ITS COMMON CAUSES

2.2.1. DEFINITION OF CHANGE

An online search in Google Scholar of “what is a project change” and “definition of project change” returns several results on change management as being the process to manage changes and not on what a change actually is; the same search on the general Google search engine provides similar results. From the relevant results the author selected the following:

- A cloud-based collaboration and project management software provider defines that “**change within the context of project management** is anything that transforms or impacts projects, tasks, processes, structures, or even job functions” [4]; and
- A company that provides trainings in change management defines **change** as a modification to the project baselines that is required in order to achieve the expected business outcome [5].

The PMBoK Glossary defines **Change** as “a modification to any formally controlled deliverables, project management plan component, or project document.” [2, page 700].

Therefore, in a project, anything causing a modification to the product or deliverable or to production processes or to the documents and processes to monitor, control and manage its production is, by definition, a change.

Changes in construction projects are usually referred to as variations, as defined by S. Naoum variations are any addition, omission, or other revision to project goals and scope, whether it increases or decreases the cost, time for completion or quality. It can be the responsibility of any party to the project or a third party [6].

2.2.2. COMMON CAUSES FOR CHANGES

There are several methods and academic work on classifications of changes according to its cause. At this point the author only refers to general causes, which are both common sense and are likely to have been experienced by any project manager in any field.

Common causes include [7]:

- Change of Project Sponsor/Owner requirements or business case/strategy;
- Changes to comply with any other stakeholder requirement, including authority or legal requirements;
- Changes to baseline regulations or law which impact the project;
- Poor definition of Project Sponsor/Owner requirements or Project scope;
- Technological advances;
- Non availability of resources;
- Differing/unforeseen site conditions;
- Inadequate project management processes or planning.

The author draws on his experience and provides real life examples, demonstrative of a few of the above common causes, on how sometimes, issues that appear to be of minor consequence, may have major impacts.

2.2.2.1 Change caused by Stakeholders

In 2007 the author was the project manager for the construction of a shopping centre in Lisbon, Portugal. As is common in such facilities, horizontal and vertical circulation studies are performed during the design stage to establish the required corridor widths and elevators/escalators numbers and specifications.

Such studies take into consideration circulations in car parking, the units' clusters, like food courts, cinemas, supermarket, and main retail outlets / anchor units. It is of high importance the early involvement of the marketing team in the project, to define leasing plans and work collaboratively with the design teams.

In this project, four months from the opening date to the public, the building envelope was complete, the public areas pavement was being executed, fit out contractors were on site and service corridors were being finalized. The anchor (largest) shops were being handed over to their owners for its fit out.

At that time, a change in strategy regarding location of anchor shops, driven by a few major shop owners, caused the leasing plan to be revised, which could change the expected circulation paths.

The circulation specialists were called to revise their study. The change to the anchor shops location would cause an overcrowding of an area of the shopping. In order to avoid the overcrowding, an additional escalator between the ground floor and the parking should be installed.

The change caused further design changes, including demolishing over 200 m² of the ground floor concrete slab already in place, additional structural works to support the new escalators, removing part of the façade to allow for the escalators to enter the building, procurement of the escalators, suspending and reprogramming several of the finishing works going on.

This triggered negotiating with contractors the additional costs and acceleration measures to mitigate any delays, changes to design, and Project Owner marketing and commercial teams to validate the solution and confirm the cost was within the project's contingencies.

A negotiation at a later date between the developer marketing team and the anchor shop owners, who were important for the shopping centre's business model, triggered the major change described above.

2.2.2.2 Change caused by Non-Availability of Resources

In 2009, the author joined the first major project of a Portuguese contractor in the Sultanate of Oman, the project had just been awarded. As it usually happens when bidding internationally in markets where there is little previous experience, the offer is prepared taking assumptions and assessing risks from a distance, without all details.

Although risks were managed during the offer preparation, issues are common while taking assumptions under such unknown circumstances.

The project involved the construction of urban utilities networks, requiring concrete chambers and a significant number of concrete slabs to embed the manhole covers. Due to the type of legal constraints and business mind set, the Sultanate of Oman's construction industry was composed of large contractors who did all in house, large material suppliers, importing most materials and small size local subcontractors / manufacturers.

Such procurement risks were assessed while initiating the project. In order to comply with the construction schedule, a few hundreds of concrete precast elements were required per month. These items were not large precast elements and therefore do not require high technology, however the production was more than any of the country's small suppliers could deal with.

Attempts were made to obtain the product from several suppliers, but there were shortcomings regarding deliverables' timely and quality. All other contractors doing similar works had in-house precast productions and the local suppliers were not used to produce such items.

After two months of attempts to procure those items externally, the only option was for the project to set up its own precast yard, bring in specialists to manage the production, train labourers for those tasks and produce the items. Naturally such start up endeavour took more time than it was foreseen.

The initial lack of precast chambers and slabs meant that part of the work could not be done or could not be completed, causing delays and loss of productivity. Even if the budgeted cost for the precast items allowed for in-house production, there was no time allowance for the set up and learning curve of a project precast facility.

The precast items required low technology and were available in the country. Any person on the position of a reasonable estimator at offer stage would not see such basic item as a major project risk for delay; the fact is that it impacted the project severely at its start.

2.2.2.3 Changes caused by poor definition of Project Sponsor/Owner requirements

In 2017, the author was managing several projects in Vietnam, one of which was an iconic high rise hotel tower. The author and his team arrived at the project midway to replace the project management and construction management teams which were there from the start. The project design was developing simultaneously with the construction, as it is common on fast track development projects.

The tower is to become this Owner's first hotel; it was noted and reported immediately that a hotel operator was not involved, not even providing technical support to the Owner for design development. Furthermore, the Owner had not decided yet if the hotel standard was to be a 4-star or a 5-star.

This lack of definition of the Owner requirements was raised immediately. The differences between 4-star and 5-star hotels are significant; not only on what is seen by guests, but mainly by what is not noticeable, additional amenities means additional requirements, additional back of house areas for hotel staff and services. There are also major differences regarding utilities, building management system (BMS) and guest management services.

All such requirements, if not defined at the start of detail design development and prior to the start of construction, may cause the project to incur in either unnecessary cost if one later decides to lower the hotel standard, or in major changes of design and of whatever is built if the standard needs to be upgraded. Hotel operators, in order to see their brand represented in a hotel they have not been involved from an early date, may impose significant changes when they enter an agreement.

Two months after the author joined the project and alerted to the risks, an operator was signed to give technical support. The changes following the operator's input caused the suspension of the construction in a few areas of the building. Because most of the ongoing work was structural, the delay was not critical; however, in terms of cost, the change had impact both on design which had parts completely redone but also on site, where adjustments had to be done to areas already built.

2.2.2.4 Changes caused by Inadequate Project Management Processes

In late 2016, the author was requested to support a near completion major project in the Middle East, in which Owner and Contractor were about to initiate arbitration. The reason for the dispute was the lack of agreement regarding cost of changes that had occurred during the project.

The change management process established by the contract was in line with best practices, however it allowed for the Owner and Engineer to give instructions without a fixed time for the Contractor to provide details of the impacts or dates for the Owner to agree to such impacts. It was dependent on the parties' good faith without imposing such good faith duty.

The fact was that both parties' expectations were defrauded. The Contractor was arguing that, although it did not present any details of estimated impacts, acted in good faith, performed the work and should be paid its costs and reasonable profit. The Owner was willing to pay a reasonable cost, but argued that the Contractor had failed to provide estimates within a reasonable time, and that the costs either incurred were not well managed or the Contractor was artificially increasing the costs.

This quasi-dispute led to the non-agreement and non-payment of the variations, causing serious cash flow issues to the Contractor. The Owner was not able to get the project completed and take over the site, causing him commercial losses.

The change process was accepted by the parties at the start of the contract, and it could be said that both acted in good faith, the Contractor executed the changes and the Owner intended to pay for the reasonable cost for the changes. However the process was not adequate or not adequately applied, with serious consequences, both financial and reputational. Surely none of the parties intended or expected that an agreed process had such impact.

2.2.2.5 Synthesis

As presented in the examples above, decisions taken by parties to a construction contract or actions by others may have major, sometimes unforeseen, consequences. Change management is of major importance in any project.

In the next sections the author presents how the latest PMBoK and PRINCE2 project management standards foresee that project changes should be managed.

2.3. DEFINITION OF CHANGE MANAGEMENT AND CHANGE CONTROL

Change Management is a term usually used for change in businesses and organizations, less so for projects. The Association for Project Management (APM) defines Change Management as “a structured approach to moving an organisation from the current state to the desired future state.” [8].

In a Construction Dictionary, Change management is defined “as the planned process used to make alterations to business or activities. Procedures and guidance are often used to specify the course of action to be taken.” [9].

Under the APM body of knowledge [10], Change Control is “the process through which all requests to change the baseline scope of a project, programme or portfolio are captured, evaluated and then approved, rejected or deferred.” [8].

The PKBoK defines Change Control as “a process whereby modifications to documents, deliverable, or baselines associated with the project are identified, documented, approved, or rejected.” [2, page 700].

PRINCE2 is another best practice project management methodology originally developed in the UK, applicable to all types of projects. It refers to project changes as inevitable, that the objective of managing changes is not to prevent them but for changes to be agreed and approved before they are executed. Like the PMBoK, it foresees that management of changes is planned from the start [11].

This dissertation refers to the management of changes under projects, specifically what in the construction industry is referred to as variations. Project management standards refer to the performing the management of such changes as Change Control.

2.4. MANAGEMENT OF CHANGES UNDER THE PMBOK

For those less experienced with a project management standard as the PMBoK, the author provides below a short introduction of its organization, and demonstrates that Change Control is considered of major importance for the management of any project.

2.4.1. PROCESS GROUPS

The PMBoK divides the project management processes in five Process Groups, each representing an independent project phase, as listed below [2, page 23]:

- Initiating Processes are performed while defining a new project, or new contract or a new phase of an existing project/contract;
- Planning Processes are performed to establish the project's scope, refine objectives and **define the plans to achieve the project's objectives**;
- Executing Processes are performed to complete the work defined in the project management plan;
- Monitoring and Controlling Processes **track, review, and regulate the progress and performance of the project, identify areas in which changes are required and initiate such changes**;
- Closing Processes are performed to formally complete or close the project or phase, or contract.

2.4.2. KNOWLEDGE AREAS

The PMBoK categorizes project management processes in ten interrelated Knowledge Areas, each defined by its knowledge requirements; in the author's view, each knowledge area represents different technical skills that a project manager is required to master, that except for Integration Management, the project manager may delegate more or less on experts. The Knowledge Areas are self-explanatory and are listed below [2, page 24]:

- Project Integration Management includes the processes and activities to identify, define, combine, **unify and coordinate the various processes and project management activities** within the Project Management Process Groups;
- Project Scope Management;
- Project Schedule Management;
- Project Cost Management;
- Project Quality Management;
- Project Resource Management;
- Project Communications Management;
- Project Risk Management;
- Project Procurement Management;
- Project Stakeholder Management.

2.4.3. CHANGE CONTROL

In any project, the Project Manager is expected to prepare the Project's Plan, describing how the project will be executed, monitored and controlled and closed. In the PMBoK, this document is referred to as the Project Management Plan and is the main output of the Planning Process Group, it is expected to include the project's Change Management Plan.

As it should be expected, management of Changes is a central and vital part of managing a project as is indicated by the PMBoK’s focus on the Performing Change Control process. Due to the potential interrelations with several processes, Project Change Control is an independent process, nevertheless considered to have the potential to impact most other processes. This is represented by the PMBoK as shown below in figure 1.

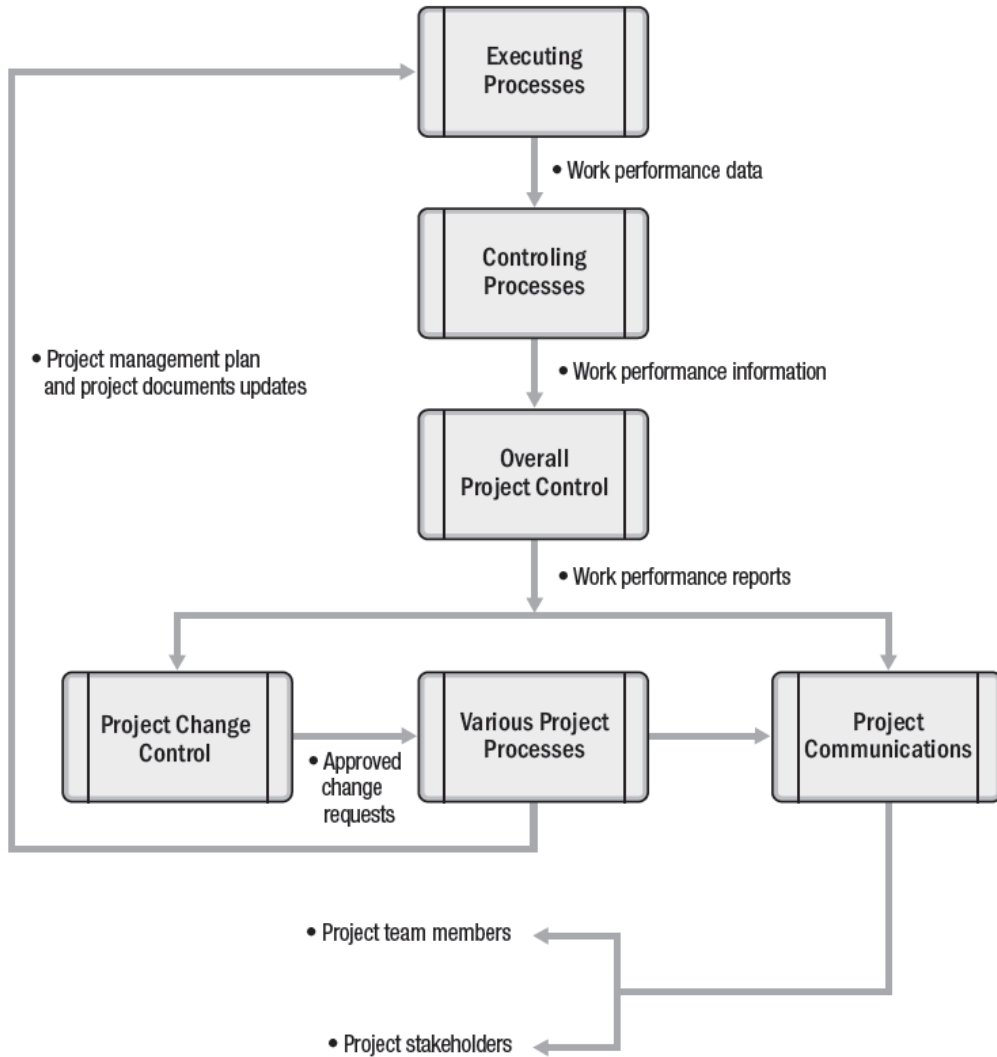
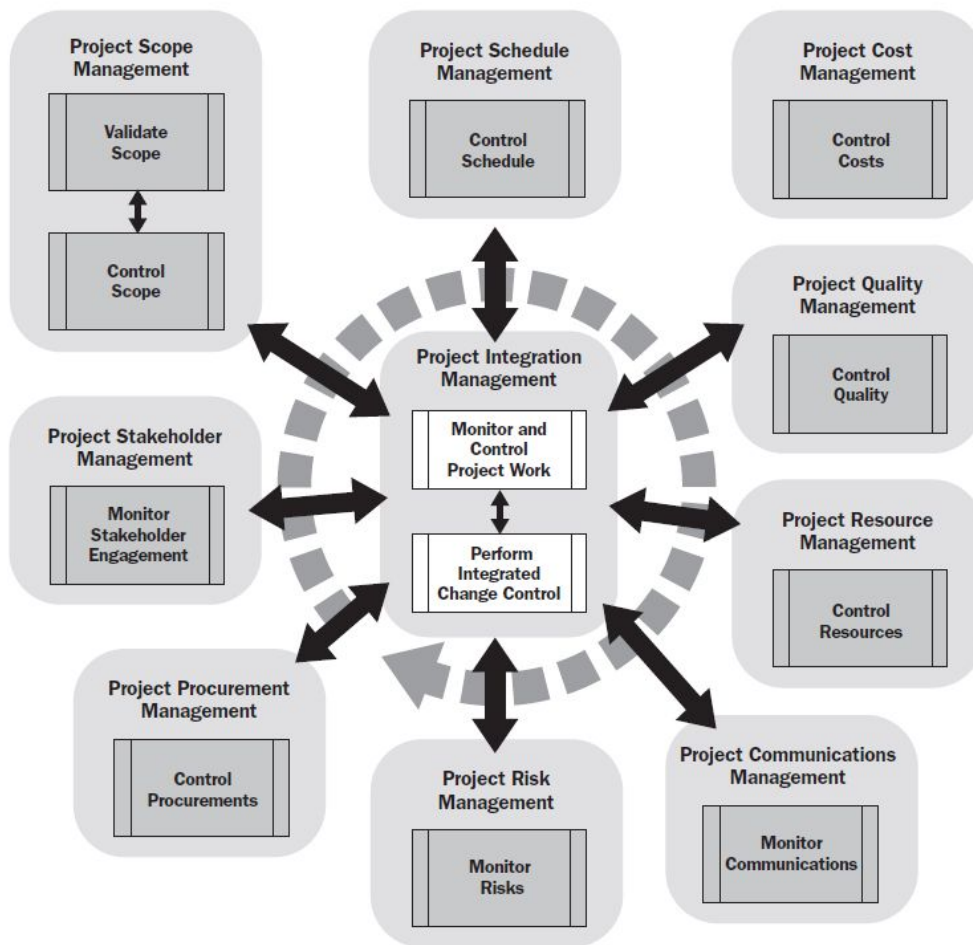


Fig.1 – PMBoK’s Project Data, Information and Report Flow [2, page 27]

The Perform Integrated Change Control is to be executed in accordance with the Change Management Plan, one of the Project Integration Management Processes and, a central part of the project Monitoring and controlling as represented in figure 2.



The dashed circular arrow indicates that the process is part of the Project Integration Management Knowledge Area. This Knowledge Area coordinates and unifies the processes from the other Knowledge Areas.

Fig.2 – PMBoK’s Monitoring and Controlling Process Group [2, page 614]

The next sections presents in detail what the Change Management Plan is expected to include and what to Perform Integrated Change Control is.

2.4.4. CHANGE MANAGEMENT PLAN UNDER THE PMBOK

As above mentioned, under the PMBoK, the Project Management Plan is expected to include a Change Management Plan, describing how change requests will be authorized and incorporated during the project [2, page 88].

The definition of the PMBoK for Change Management Plan is “A component of the project management plan that establishes the change control board, documents the extent of its authority and describes how the change control system will be implemented.” [2, page 700].

The PMBoK further describes the Change Management Plan objectives in several of its processes as:

- Providing the direction for managing the change control process, and documenting the roles and responsibilities of the change control board [2, page 116];
- Defining the process for managing change on the project [2, page 169];
- Containing information about how seller-created changes will be processed [2, page 495];
- Describing the process for submitting, evaluating and implementing changes to the project [2, page 525]; and
- A component of the project management plan that establishes the change control board, and documents the extent of its authority, describing how the change control system will be implemented [2, page 700].

From the definition and objectives mentioned, the author considered the PMBoK and his experience and presents that, in the author's view, the Change Management Plan should establish:

- The roles and responsibilities to perform the Integrated Change Control;
- Who has the authority and/or how someone is authorized to perform such roles and responsibilities;
- The process for initiating, submitting and processing Changes;
- The process for evaluating Changes impacts;
- The process for approving Changes;
- The process for implementing Changes on the project;
- The communicating process throughout the Change lifecycle.

2.4.5. INTEGRATED CHANGE CONTROL UNDER THE PMBOK

The PMBoK defines Change Control as “A process whereby modifications to documents, deliverable, or baselines associated with the project are identified, documented, approved, or rejected.” [2, page 700] and defines Perform Integrated Change Control as “the process of reviewing all change requests, approving changes and managing changes to deliverables, organizational process assets, project documents, and the project management plan, and communicating the decisions.” [2, page 712] for which the Project Manager is the ultimate responsible [2, page 115].

The PMBoK provides further guidance stating that Integrated Change Control:

- Occurs throughout the project [2, page 67];
- It may involve a change request [2, page 67] to initiate the change [2, page 112], which may require information on requirements and/or quality change, and estimated schedule and cost impacts, any specific resource requirements and other risk;
- It is the only way to change the project management plan once the project is baselined [2, page 83];
- Includes reviewing and approving changes and scheduling its implementation [2, page 93];
- Delivers as output the approved change request [2, page 93].

2.5. MANAGEMENT OF CHANGES UNDER PRINCE2

The importance of management of project Changes is not a PMBoK exclusive, it is common to any recognized best practice project management standard. To elaborate and characterize similarities and differences, the author presents the general organization and the specifics on Change Control for PRINCE2, another best practice project management approach used in over 50 countries and in a variety of fields [12, page xvii].

As is presented above for the PMBoK it must be said that what is presented on PRINCE2 is a simplistic approach only to provide context and does not include all details or background necessary to fully detail this best practice project management standard.

2.5.1. AREAS OF PERFORMANCE

PRINCE2 establishes that managing a project involves managing the following six Areas of project performance [12, page 6]:

- Scope;
- Time;
- Quality;
- Cost;
- Risk;
- Benefits.

Such areas of performance are to be managed through Processes which intend to ensure the right management activities are done [12, page 7]. The Processes under PRINCE2 are structured in four main integrated elements, as follows:

- Principles;
- Processes;
- Themes;
- Project Environment.

These integrated elements are presented below.

2.5.2. PRINCIPLES

Principles are the core concepts to which the rest of PRINCE2 adheres to, the Principles are [12, page 16]:

- Continued Business Justification;
- Learn from Experience;
- Defined Roles and Responsibilities;
- Manage by Stages;
- Manage by Exception, meaning that each level of the project management team structure defines the authorities and tolerances given to the level under it [13];
- Focus on Products;
- Tailor to Suit the Project Environment.

2.5.3. PROCESSES

The purpose of the PRINCE2 Processes is to ensure one or several of the Principles is implemented.

PRINCE2 establishes seven main Processes divided into sets of Activities, defining who should be responsible for each Activity and what management documents could be created, reviewed or updated at each time of the project. These seven processes are:

- Starting up a Project;
- Directing a Project;
- Initiating a Project;
- Controlling a Stage;
- Managing Product Delivery;
- Managing a Stage Boundary;
- Closing a Project.

These processes may be seen as a different organization of the PMBoK's process groups.

2.5.4. THEMES

The Themes under PRINCE2 represent the areas to be called upon while managing the project. Each theme may be useful to a few or to all processes. The Themes are:

- Business Case;
- Organization;
- Quality;
- Plans;
- Risk;
- **Change**;
- Progress.

PRINCE2's structure is different from the PMBoK regarding the working of, its processes and themes, this is not the subject of this dissertation and therefore the aspect is not detailed.

What is relevant is that PRINCE2 nominates Change as one of the main Themes to be used while actively performing any Processes and its Activities, which are required to manage a project.

2.5.5. PROJECT ENVIRONMENT

In the author's opinion, PRINCE2 has taken a step forward towards detail when compared with the PMBoK which leaves some aspects more open.

PRINCE2 establishes an integrated element to deal with the fact that the standard needs to adjust to different types of projects, with differing characteristics, being developed in different environments. PRINCE2's Project Environment presents methodologies to deal with such adjustments.

There are other two main parts in PRINCE2:

- Roles presenting the recommended hierarchical structure a project should follow and usually are managed under the Organization Theme; and
- the Management Products which are the tools developed to manage the project, as are plans, reports, logs, means to achieve the end. If and when necessary, specific items will be described.

2.5.6. CHANGE MANAGEMENT UNDER PRINCE2

PRINCE2 recognizes that changes are inevitable, that the project manager must ensure that the impact of a change are considered while deciding if that change is to be implemented, and that such decisions are taken at the right authority level [12, page 226]. This methodology establishes that Changes can only be caused by Issues categorized under three types:

- Request for Change;
- Off-specification meaning something that is required to be provided/done and that is not or has not been foreseen;
- Problem/concern is any other issue that needs to be resolved or escalated by the project manager and cannot be categorized in one of the above types.

It is considered that anyone may raise an Issue by contacting the project manager who should document the Issue in the Issue Register.

Regarding authority, the Project Board is the entity expected to evaluate and decide on Changes. However, if the Project Board expects the project to have a large number or highly complex Changes, as it the case of construction projects, the Project Board is expected to delegate to a person or group (Change Authority) a certain level of authority to evaluate and/or approve changes. The Project Board must establishing constraints as are [12, page 230]:

- Limit the amount of cost the Change Authority may approve;
- Limit the time impact the Change Authority may approve;
- Limit the change to product quality requirements Change Authority may approve;

Any other constraint or process may be established, as would be establishing different constraints for different people/levels of authority.

PRINCE2 establishes a process for Issue and Change Control divided in 5 stages. The process flow is presented below, see figure 3.

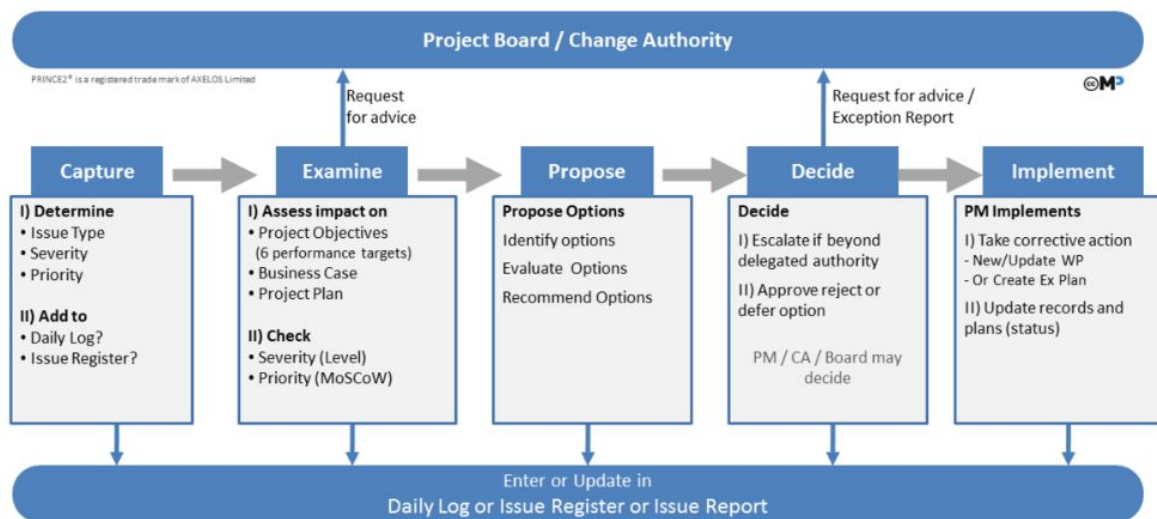


Fig.3 – PRINCE2 Issue and Change Control Procedure [11]

Each of the process stages is presented below.

2.5.6.1. Issue and Change Control Procedure Capture Stage

Once the Project Manager becomes aware of an important Issue, as would be one likely to cause a Change, it must include it in the Issue Register, as per the example in figure 4

Document: Issue Register		Project: Pen Project		Author: Project Manager		Date:			
Data Date: Jul 19, 2013									
ID	Description	Type	Date Raised	Raised By	Report Author	Priority	Severity	Status	Closure Date
01	Selected supplier sent the catalog three days later than expected	Problem/concern	Jun 29, 2013	Rose Carr	Rose Carr	High	Level 2	Closed	Jul 1, 2013
02	Five evaluators did not return the forms in time	Problem/concern	Jul 18, 2013	Rose Carr	Rose Carr	High	Level 2	Open (last updated Jun 30, 2013)	
03	Evaluation forms of four evaluators do not seem precise	Off-specification	Jul 18, 2013	Rose Carr	Rose Carr	High	Level 0	Open (last updated Jun 30, 2013)	

Fig.4 – PRINCE2 Issue Register [11]

For each Issue in the Issue Register, the Project Manager must prepare, or delegate and review, an Issue Report, which is expected to include at least the following information:

- Information from the Issue Register, including Issue ID, Issue Type, Date Raised, Raised by, Issue Report author, Priority and Severity;
- Issue Description;
- Issue Cause;
- Impact Analysis (Examine stage);
- Recommendation (Propose stage by the Project Manager or the person authorized to do such Recommendation);
- Decision (by the Project Board or the person or entity authorized to take such decision).

The output of this stage is the updated Issue Register and the Issue Reports for any new issue.

2.5.6.2. Issue and Change Control Procedure Examine Stage

Once the capture stage is performed, the Project Manager is responsible to examine the matter in detail, performing an impact analysis and to prioritize the Issue. The impact analysis requires assessing [12, page 235]:

- What impact the Issue has or will have on the six Areas of Performance;
- What impact the Issue has or will have on the environment outside the project, on stakeholders, or other projects which may be affected by this Issue;
- What impacts the Issue has on the business, user, and supplier perspective of the project.

In terms of prioritizing Changes, the process flow refers to the MoSCoW method, referring to prioritization by considering if each Change is something that the project Must have, Should have, Could have, or Won't have this time. The results of this assessment require the Project Manager to update the Issue Register and Issue Report.

2.5.6.3. Issue and Change Control Procedure Propose Stage

Once the Issue is examined, the Project Manager must propose how to deal with the Issue, eventually changing requirements, accepting changes to the baselines, or any other relevant options the Project Manager believes the Project Board should consider.

The Project Manager may be supported by expert or other parties to establish available options and their specific impacts.

By the end of this stage, the Project Manager must have an Issue Report, an evaluation of the impacts and proposed decision on the Change.

2.5.6.4. Issue and Change Control Procedure Decide Stage

The decision stage is coordinated by the Project Manager, who may have been delegated the Change Authority to decide up to a certain amount of cost or time adjustment, or authority to accept an off-specification Issue, and/or decide on the Issue.

If the Project Manager does not have the authority to decide, the issue must be escalated to the Project Board or to the Change Authority to whom the Project Board delegated the matter. Such escalation requires the Project Manager to prepare an Exception Report, detailing the options referred in the Issue Report, including a reasoned recommendation of one of the options.

A decision is supposed to be accepting one of the options proposed or deciding to follow another path, or to reject the need for the change, or to defer the decision accepting impacts of such delay or to request more information.

2.5.6.5. Issue and Change Control Procedure Implement Stage

Once a decision is taken, the Project Manager is expected to update the Issue Register and Issue Report, take the necessary actions and inform the persons required to act upon the decision. Once the Issue is closed, the Project Manager is required to update again the Issue Register and Issue Report.

The process presented by PRINCE2 is more detailed than the PMBoK, however both are aligned regarding the main aspects of managing project changes. In summary, both standards define that:

- The management of Changes is a crucial process while managing a project;
- The process to manage changes is planned at the start of the project;
- Such process details the roles and authority of each person or entity involved in the change process;
- The process starts with the identification of the change, requires assessment of impacts, recommendation of actions, decision, execution and closing;
- The Project Manager is the main responsible for Change Control.

The next section presents examples of processes from two different organizations and one process proposed by the author in one of his projects.

2.6. CHANGE MANAGEMENT PLAN AND CHANGE CONTROL EXAMPLES

Organizations have taken project management standards and their own experience to introduce Change Management Plans as part of their mandatory project procedures. The author has also developed Change Management Plans for large projects, when Project Sponsors/Owners did not require their own to be implemented. This section presents examples of Change Management Plans.

2.6.1 WEST VIRGINIA OFFICE OF TECHNOLOGY

The West Virginia Office of Technology [14] is a public entity. Its objectives are to develop an organized approach to information resource management in West Virginia, USA, while providing technical assistance to state entities in the design and management of information systems, [15] developing IT projects. As part of its project management document templates, it has a concise Project Change Management Process, its flowchart is presented in figure 5.

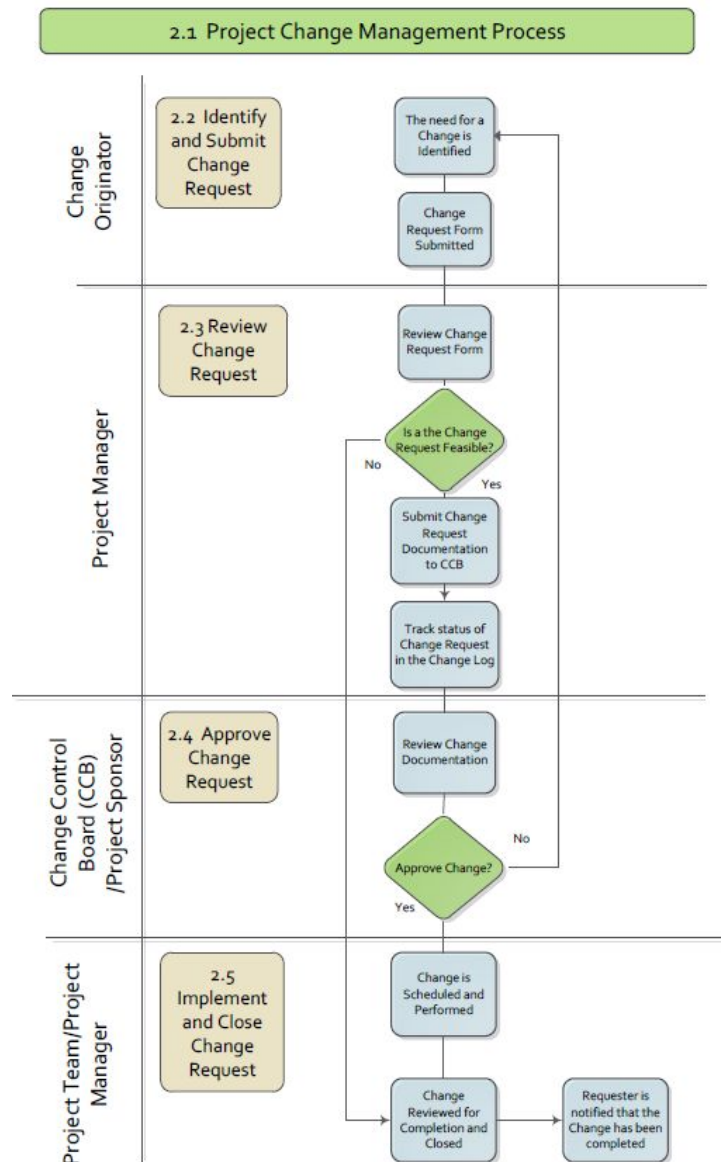


Fig.5 – West Virginia Office of Technology Project Change Management Process [14, page 2]

The template for Project Change Management Process from the West Virginia Office of Technology has a total of five pages, divided in the following four sections:

- Introduction, presenting what is the process and when it is supposed to be used;
- Change Management Process, providing the process flowchart presented below and explaining each of the sub-processes;
- Change Management Roles, explaining the role and authority of each of the entities involved in the process;
- Change Management Documents, presenting the templates for Change Request Form and Change Log.

In the author's opinion, it is a good example of a simple document, fit for the purpose of the organization and the type of projects it manages and supports, establishing what a change management plan is expected to do.

2.6.2 CENTERS FOR DISEASE CONTROL AND PREVENTION

The American Centers for Disease Control and Prevention (CDC) is the governmental entity responsible to protect America from health, safety and security threats, both in foreign countries and in the U.S. [16]. Their projects are health related, ranging from health awareness campaigns to high tech laboratorial research.

The CDC's Change Management Plan template for its projects is structured as follows [17]:

- Introduction, presenting the purpose of the document;
- Change Management Process, providing the process flowchart, the expected contents of the Change Request Form and Change Management Log, a section on evaluation criteria regarding the change's priority, type and status and the list of members of the Change Control Board;
- Responsibilities, in which each of the roles of the people involved is to be detailed;
- Appendixes, which include the approval of the Plan, and templates for the Change Requests Form and Change Management Log.

The look of this document is different from the West Virginia Office's one and the process flow is less detailed. On the other hand the CDC's template requires the change to be assigned to a certain predefined type and for a priority to be given, which the West Virginia Office one does not.

Both documents comply with the best practices standards and with the overall intent of this document, to guarantee that any project has an established process on how changes are managed.

2.6.3. CHANGE MANAGEMENT PLAN FOR THE SULTAN QABOOS NAVAL BASE BY THE AUTHOR

In mid-2013, the author was appointed as Project Manager for the Design, Construction Management and Supervision teams of the Sultan Qaboos Naval Base in Oman.

During the design stage of this megaproject, while preparing the contract documents for the Owner to include in the construction tender, after consultation with the Client, the author understood that, as usual in construction contracts, further to the outdated typical contractual mechanism on how a change is processed during construction, the Client had no Change Management Plan to be implemented during construction.

The existing contractual mechanism was not aligned with the Owner’s internal processes on how the parties should initiate, review and approve changes prior to a formal contractual variation being issued.

The author presented a Change Management Plan for Client approval, which was in line with the contractual mechanism, while proposing:

- contents and template of a change request form, not limited but including the date by which the change is required to be approved, the impacts of the change and of its eventual non-approval by the time limit; the change category, the details of the cause of the change and why it is justified to change;
- a permanent change control board and frequency of formal regular meetings and process for the Client to approve the change; including simplified processes for changes that only affect works quality and for changes that have minor impact on cost or time baselines, and a general process for changes with major impact;
- A formal negotiation stage as a dispute avoidance measure, to align Owner’s and Contractor’s expectations.

The flowchart of the process is presented below, see figure 6.

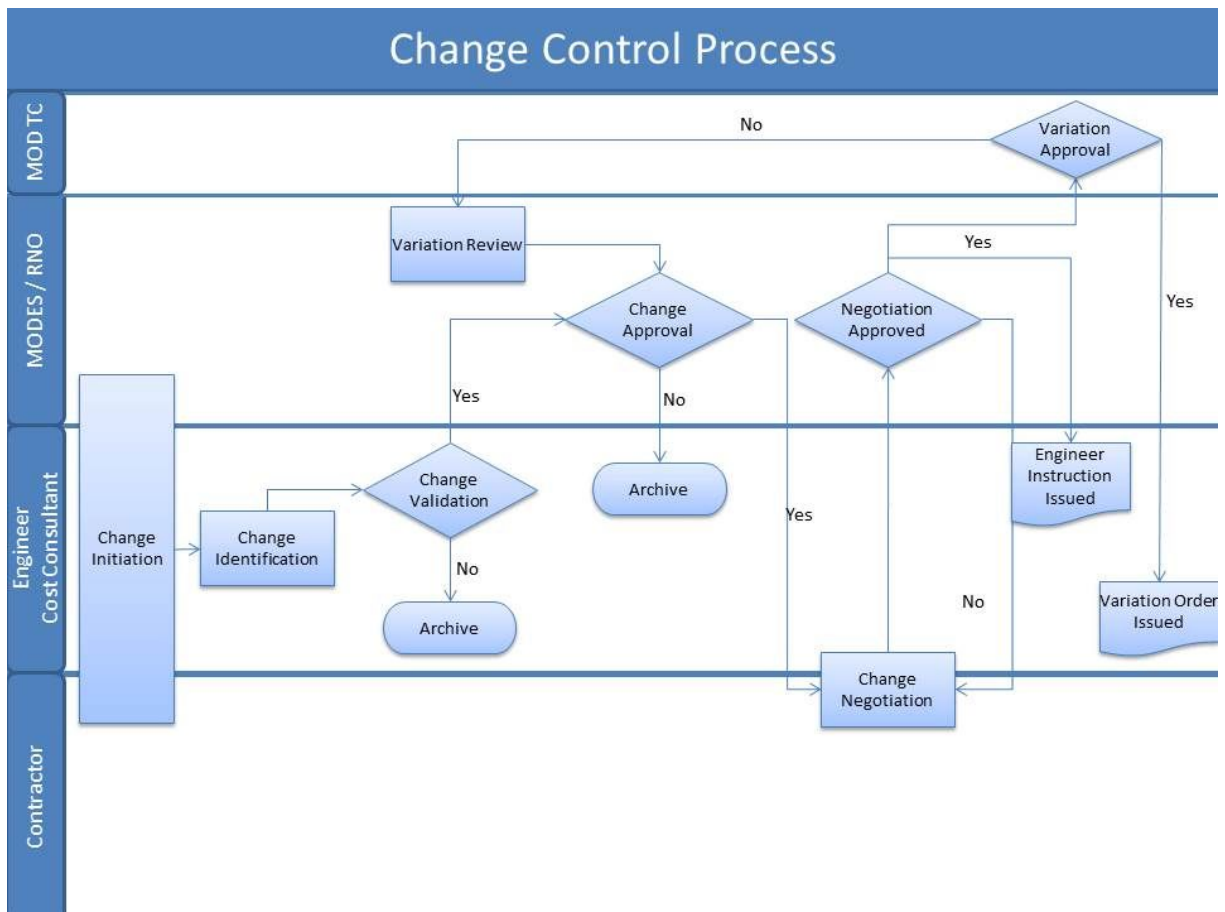


Fig.6 – Sultan Qaboos Naval Base proposed Change Control Process by the author in 2015

The process proposed by the author for the Sultan Qaboos Naval Base is in line with the PMBOK's and PRINCE2 methodologies regarding the stages and importance of defining approval authorities, the author recommended the setup of a permanent change control board, in line with the standing DAAB under the FIDIC Red Book 2017 is presented in Chapter 3.

The author proposed for a Change Request Form which would be a live document, keeping all the historical aspects, and assessment of impacts, a merger between a Change Request Form and PRINCE2's Issue Report.

The author took into consideration the contractual aspect, including stages for negotiation which usually take place informally, and for which a formal process was proposed.

The issuing of the contractual instruction by the Engineer and approval of a variation order by the Project Owner were included in the process, for these to be part of the Project's contractual requirements for the change to be contractually executed.

The author believes that in the circumstances of this project, and of others, early cooperation and detailed assessment of impacts, allowing for the alignment of Employer and Contractor expectations, is a dispute mitigation measure which contributes to avoid issues and/or conflicts between the parties.

3

MANAGEMENT OF CHANGES IN CONSTRUCTION PROJECTS

3.1. INTRODUCTION

In Chapter 2 the author introduced what are changes, its causes, how internationally recognized project management best practices foresee project changes to be managed, and provided examples of change management processes. As presented, the PMBoK and PRINCE2 agree that changes can be to the project's product or its production process, or a change to the project's management processes.

This chapter narrows the focus to changes in construction projects, taking guidance on the best practice project management standards referred to in the previous chapter and on the newly published Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, Second Edition (FIDIC Red Book 2017) [18], the author presents:

- What are the common impacts of changes in large international construction projects;
- The PMBoK's Construction Extension considerations regarding change control;
- The change control process under the internationally used FIDIC Red Book 2017;
- That the FIDIC Red Book 2017 process is aligned with Project Management best practices; and
- Comments on FIDIC Red Book 2017 new provisions regarding change management.

3.2. IMPACTS OF CHANGES IN CONSTRUCTION PROJECTS

The construction industry accepts that a project is considered successful if it is completed according to the budgeted cost, schedule and specified level of quality [19, page 17]. Due to its complex nature, construction projects are especially predisposed to a high number of changes. It was said that in construction, project changes are mostly inevitable [20].

Published papers have addressed project critical success factors or project failure factors and impact of changes. The examples presented below is demonstrative of the impact of changes.

Industry research [21] indicates that approximately 40% of all construction projects undergo more than 10% change, measured by the comparison between the final project cost and the estimated/initial project cost. In average, when the value of changes is limited to 5%, productivity exceeds planned rates in approximately 60% of projects. However, when value of changes exceeds 20%, productivity falls significantly below planned rates.

A paper on construction Projects Failure Factors in Saudi Arabia published in 2014 assessed 73 causes of delay, it established that delays caused by change orders are the most common cause of delay and may cause up to 70% of projects' time overruns [22].

A study in Turkey concluded that design and material changes, delay of payments and contractors' cash flow difficulties were the three most significant delay factors out of 34 factors assessed [22], and that cash flow and financial issues are some of the most critical factors, commonly triggering project failure and/or major delay [22].

The study concluded that the most common project failure factors were:

- (1) poor risk management;
- (2) budget overruns;
- (3) poor communication management;
- (4) **schedule delays**;
- (5) poor estimation practices;
- (6) **cash flow difficulties**;
- (7) design discrepancies;
- (8) **lack of efficient change management**;
- (9) **inadequate project structure**; and
- (10) lack of teamwork.

Not only lack of efficient change management is a main cause of project failure, but in the author's experience, the other three factors marked in bold, may be, or are, caused by lack of efficient change management.

In a separate study on large construction projects in developing countries, Nguyen, Ogunlana and Lan (2004) categorize the top ranking problems/failure factors in four major categories as: "incompetent designers and contractors, **poor estimation and change management**, social and technological issues, and improper techniques and tools." [22, page 38].

The conclusion of both studies is similar, and in line with the author's twenty years of experience in construction projects, in different regions, types of construction project.

Any experienced Contractor or Employer is aware that **inappropriate Change Management is a risk in any large construction project and often changes are the main cause for delays**. Project delays and variations are amongst the main causes for Contractor's cash flow issues, and such financial issues are one of the most typical causes of project failure. Therefore, a significant amount of Project Failure causes may also be indirectly attributed to inadequate management of project changes.

In the next pages the author presents the state of the art on how project management best practices and international contract conditions foresee that changes are to be managed in construction projects.

3.3. CONSTRUCTION EXTENSION TO THE PMBOK

The PMI publishes extensions to the PMBoK describing industry-specific supplemental knowledge and practices. The Construction Extension to the PMBoK Guide (Construction Extension) was first published in 2003 and its latest update was published in 2016 [23, page III].

The PMI publishes a construction specific extension to the PMBoK because construction projects usually have:

- Unique or indefinite aspects and complexity;
- Differing knowledge and practices to improve efficiency, if applied; and
- Industry-specific knowledge.

The Construction Extension includes two additional knowledge areas and an annex which a Project Manager of Construction Projects must actively address:

- Project Health, Safety, Security and Environmental Management;
- **Project Financial Management**; and
- **Managing Claims**.

The Construction Extension states that construction projects may involve a wide range of stakeholders, a complex range of specialists and contractors, sometimes resulting in a one of a kind product. Design and production stages may occur simultaneously, requiring continuous validation of the design intent, Employer requirements and investment/business case feasibility.

Due to its complexity and size, large or mega construction projects, usually involve high degrees of risk, requiring integration of several engineering, architecture and technology disciplines, which may demand unique resources and techniques [23, page 2].

The construction industry, in particular when it comes to large projects, is a global competitive market and its contracts usually carry large penalties or damages for delays, requiring specific advanced planning and scheduling techniques, cost and risk management, document controls and in some cases continuous forensic analysis [23, page 3].

Construction projects may be subject to specific circumstances, as are:

- Being delivered in phases;
- A significant number of stakeholders and their interfaces;
- Project specific risk distribution amongst stakeholders;
- Time and cost baselines of the essence to the project and without margin for adjustment;
- Special funding instruments;
- Differing procurement strategy levels and owners; and
- Specific legal and/or regulatory constraints.

The author is of the opinion that construction projects are very specific, and best practices which may work for more general types of project, may not be blindly transferable to the management of construction project without due consideration, in particular the management of changes.

The following section addresses what the Construction Extension of the PMBoK specifies regarding management of project Changes.

3.4. MANAGEMENT OF CHANGES UNDER THE CONSTRUCTION EXTENSION OF THE PMBOK

The Construction Extension states that, due to its complexity or other factors, in construction projects changes are inevitable [23, page 22]. That at the start of a construction project, its scope and/or requirements may not be fully defined, or Owner's needs may change throughout the project, causing scope creep, and therefore construction projects should have "robust change management processes" [23, page 49].

One may infer the importance of management of changes in a construction project, by the fact that **the Construction Extension’s only reference to project critical success factors is when it refers to the existence and implementation of an integrated Change Management Plan** [23, page 22]. Integrated Change Control is a significant process and its inadequate management leads to negative effects and eventually to contractual disputes between Owner and Contractor [23, page 40].

3.4.1. INTEGRATED CHANGE CONTROL

The Construction Extension further details the Integrated Change Control process, referring that:

- Several parties may be involved;
- A change in a construction contract may trigger a change in a design contract, impacting several parties and contractual obligations;
- One project may include several contracts, each with different change management processes, managed by or involving different parties [23, page 45]; and
- A Change Order Log is required, as per the example presented in figure 7.

Change Order Description	Source Document Reference	Construction Change Directive	Change Order Request	Change Order Proposal	Change Order Cost or Responsibility	Initial Cost Proposal	Time Extension Request (# Days)	Cost and Time Extension Negotiated Amount	Cumulative Cost Amount	Remarks
Add structural steel landing extension	RFI 57	CCD #4	N/A	COP #19	Design clarification	\$12,656	0	\$11,344 and 0 days	\$33,555	
Unknown subgrade pipe interference	RFI 58	N/A	COR #14	COP #20	Unknown condition	\$3,000	2 days	\$3,000 and 2 work days	\$36,555	

Fig.7 – Construction Extension Change Order Log [23, page 40]

The Construction Extension details include considerations of what Change Control concerns in construction projects, table 1 presents such inputs and compares them to the PMBoK.

Table 1 – Comparison between Change Control under PMBoK and the Construction Extension

Change Control characteristics under the PMBoK*	Intent of Change Control under the Construction Extension [23, page 40]
It may involve a change request to initiate the change	Identify possible changes
It is the only way to change the project management plan once the project is baselined	Review the change’s impact on project scope, cost, schedule, and work activities in terms of quality and safety
Reviewing and approving changes and scheduling its implementation	Notify the Employer in accordance with procedures and time requirements
Delivers as output the approved change request	Process the change request as per the contract documents and a proper project record is maintained

* section 2.4.5 of this document

3.4.2. PARTIES' RESPONSIBILITIES

The Construction Extension states that “it is the responsibility of the contractor or the contract administrator to identify changes in a timely manner and to advise the owner, in writing, of the change effect on the project’s quality, cost and time of performance, and that in larger or government projects there may be a formal control board to give approval” [23, page 41].

It addresses the authority and time to approve changes, by stating that changes should be resolved by the contract representative, duly authorized to do so, and in timely fashion. There should be a mechanism avoiding contractors to act on a change request from an unauthorized person [23, page 41].

The Construction Extension also indicates that the parties involved in construction projects must have industry-recognized knowledge when assessing change impacts in order to avoid unwanted claims [23, page 61]. More on the aspect of desired skills and requirements is presented in Chapter 5.

3.4.3. CHANGE CONTROL IMPACTS THE PROJECT FINANCIAL MANAGEMENT

Financial management is the process to acquire, assess and manage the project financing, including monitoring cash flows. As presented above, cash flow difficulties are one of the main causes of project failure. Today’s construction project manager must understand this knowledge area as one of major importance.

The Construction Extension presents Integrated Change Control and Financial Management together in an example of construction project phases, as shown below, see figure 8.

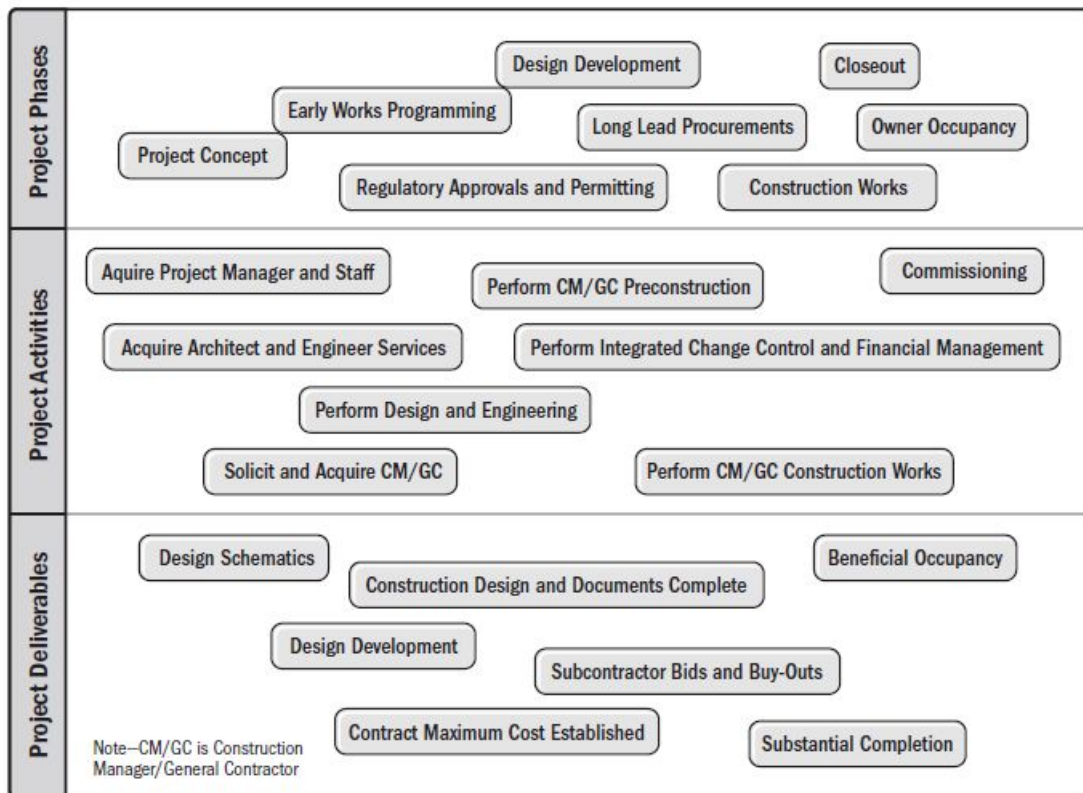


Fig.8 – Example of high-level phases of a construction project across its project life cycle [23, page 31]

Construction contract variations may cause changes to a project's cash flow baselines of both Contractors and Owners. If the Change Management process, in particular the approval of changes, is not in line with the needs of the project and the parties, it is likely to cause serious impacts to the parties cash flows. A case study on this matter is presented in section 4.4.6.

The author summarized above the circumstances and criteria which the PMBoK consider to be found in construction projects and should be addressed when dealing with changes. A particularly important point is the need of compliance with the construction contract conditions when it comes to acceptance and communication of a change.

To elaborate on this matter, the next section addresses Change Control in Construction Contracts, presenting the process under the FIDIC Red Book 2017.

3.5. THE FIDIC STANDARD CONDITIONS OF CONTRACT FOR BUILDING AND ENGINEERING WORKS DESIGNED BY THE EMPLOYER

Many standard contract forms for the construction industry are elaborated by different entities. The most commonly used and adapted worldwide are the forms published by the International Federation of Consulting Engineers (FIDIC), founded in 1913 [24].

Over the years FIDIC developed into a global organisation with Member Associations representing countries from all regions of the world. FIDIC has an essential role for the consulting engineering industry, and almost every country in the world has Member Association. FIDIC also partners with the World Bank and other Multinational Development Banks (MDB), working in different geographical regions, to ensure the application of international contract standards developed by engineers to deliver the world's infrastructure, in line with FIDIC's core principles for over 100 years: Quality, Integrity and Sustainability [25].

The first edition of the Conditions of Contract (International) for Works of Civil Engineering Construction was published in August 1957. This type of contract, to be used when design was provided by the Employer to the Contractor, was continuously revised and updated and it is referred to as the FIDIC Red Book.

Although FIDIC publishes other standard contract forms for specific circumstances, the processes for management of changes under the several FIDIC contract types are similar and follow the same principles. This dissertation focuses on change under construction contracts in general and refers to the FIDIC Red Book for guidance and as example.

The FIDIC Red Book establishes general conditions for the contract between the Employer and the Contractor, while establishing duties and rights of the Engineer, who is the "de facto" project manager, while not being a party to the contract.

The FIDIC Red Book was revised overtime and its fourth edition, published in 1987, introduced a key feature, the express term requiring the Engineer to act impartially when giving a decision or taking any action which might affect the rights and obligations of the parties [24].

In 1994 FIDIC established a task force to update both the Red and the Yellow Books in the light of developments in the international construction industry, and in 1999 FIDIC published four new contracts, including the Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer: the FIDIC Red Book 1999 [24].

Due to the trend by the world's banking community to use the FIDIC forms of contract, FIDIC published the Multilateral Development Banks (MDB) Red Book in 2005, introducing several changes regarding financing but also others, one of which very relevant for the change management process, the MDB Red Book requires the Engineer to obtain the Owner's approval in order to agree for a certain extension of time for completion and/or additional associated costs, and/or instructing or approving variations [24].

Furthermore, the MDB Red Book stated "The Employer shall promptly inform the Contractor of any change to the authority attributed to the Engineer", which is significantly different from the FIDIC Red Book 1999 in which it was stated that "The Employer undertakes not to impose further constraints on the Engineer's Authority, except as agreed with the Contractor."

Although this change was logical in the sense of project's financed by development banks, this was adopted by many public and private Owners in their ad-hoc contracts based on the FIDIC Red Book. In most cases this adoption was introduced for additional control, without assessing if the project circumstances required it or if the Owner's internal processes were compatible with the adjustment. The consequence of this type of clauses is further discussed in section 4.4.

Taking into consideration the need to reflect current best practice and issues raised by users over 18 years, FIDIC updated the 1999 version of its contract form and in 2017 issued the FIDIC Red Book 2017. FIDIC's main goal is to increase clarity and certainty, and expects the attest amendments to lead to fewer disputes and more successful projects [26].

In the following sections the author presents:

- Relevant definitions and what constitutes a change under the FIDIC Red Book 2017;
- Change Control under the FIDIC Red Book 2017;
- A comparison of the FIDIC Red Book 2017 change process with the best practices project management standards and commentaries;
- Comments on FIDIC Red Book 2017 new provisions regarding change management and the issues those clauses address.

3.6. MANAGEMENT OF CHANGES UNDER THE FIDIC RED BOOK 2017

In section 2.2, the author presents that change may be any addition, omission, or other revision to project goals and scope, whether it increases or decreases the cost, time for completion or quality. It can be the responsibility of any party to the project or a third party.

Furthermore, as referred in section 2.2.1, project changes may be to the product or deliverable, or to the process of producing it or to the documents and processes to monitor, control and manage its production.

Below are presented and explained a few definitions to introduce what amounts to Changes under the FIDIC Red Book 2017.

3.6.1. RELEVANT DEFINITIONS UNDER THE FIDIC RED BOOK 2017

The first Sub-clause of the FIDIC Red Book 2017 [18, Sub-clause 1.1] lists eighty eight definitions, providing meanings of several terms referred throughout this standard condition of contract.

In construction projects a change is commonly called a Variation; under the FIDIC Red Book 2017 the following definitions are relevant to understand what a Variation is:

- Works are defined as “the Permanent Works and the Temporary Works, or either of them” [18, sub-paragraph 1.1.87];
- Temporary Works may be of every kind required on Site for the execution of the Works, not including Contractor’s Equipment [18, sub-paragraph 1.1.80];
- Permanent Works means “the works of a permanent nature which are to be executed by the Contractor under the Contract” [18, sub-paragraph 1.1.64];
- Variation is “any change to the Works, which is instructed as a Variation under Clause 13” [18, sub-paragraph 1.1.86].

Clause 13 defines that, when the Contractor receives a formal instruction, a Variation may include [18, Sub-clause 13.1]:

- “Changes to the quantities of any item of work;
- Changes in the quality or characteristics of an item of work;
- Changes to the levels, positions or dimensions of any part of the works;
- Omission of any work (unless it is to being omitted for another to carry out, in which case this can only be done if the parties agree);
- Any additional work, Plant, Materials or services necessary for the Permanent Works—this can include associated testing etc; and
- Changes to the sequence or timing of the execution of the Works.”

Therefore, a Variation may be a change to Permanent or Temporary Works as long as instructed under Clause 13 of the FIDIC Red Book 2017 and may be of any of the natures presented above. The next section presents the process of change itself and how it is intended to be executed.

3.6.2. CHANGE PROCESS UNDER THE FIDIC RED BOOK 2017

The variation process under the FIDIC Red Book 2017 may be initiated by any of the following ways [27]:

- The Engineer may instruct a Variation under Sub-clause 13.3.1 (known as a Variation by Instruction);
- The Contractor may initiate its own proposals under Sub-clause 13.2 (Value engineering);
or
- The Engineer may request a proposal from the Contractor under Sub-clause 13.3.2 (known as a Variation by request for proposal).

Except for the initiation, the following steps of the variation process are similar. If the Contractor proposes a variation, the Contractor must submit the necessary details, which the Engineer evaluates and for which must obtain the Employer’s consent. If consent is obtained, the Engineer instructs the Variation as per the process below and initiates the negotiation stage. This is the only case when Employer’s consent is required.

If the Engineer requests a proposal to the Contractor, the Contractor submits the necessary details and then the Engineer is still required to instruct the Variation. The general process when the Engineer instructs a Variation is presented graphically below; see figure 9.

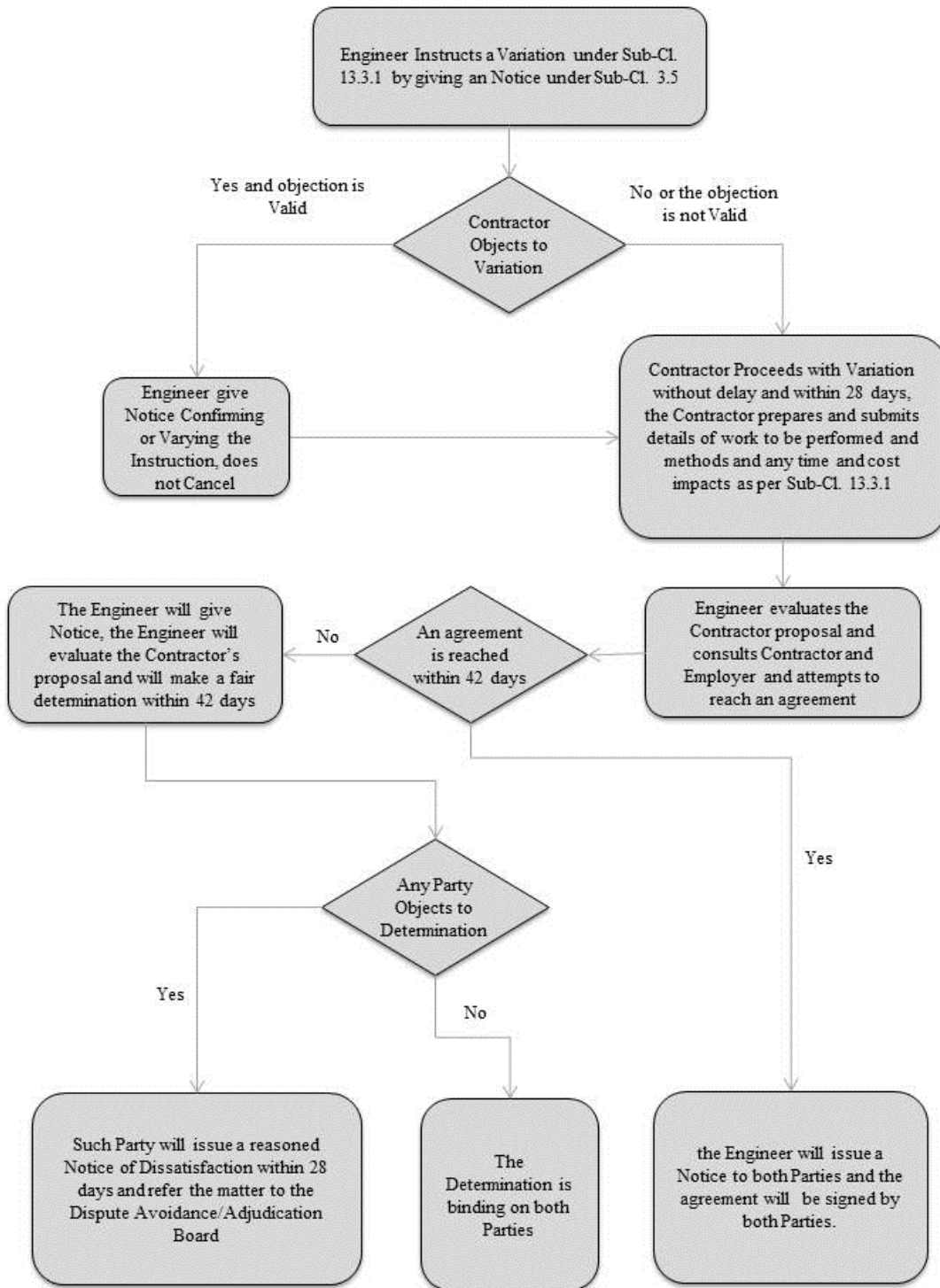


Fig.9 – General Variation Process under FIDIC Red Book 2017

By assessing the above flowchart, several stages can be identified. Below, the author compares between the methodologies recommended by the PMBoK and PRINCE2 and the process under the FIDIC Red Book 2017.

3.7. COMPARING THE FIDIC RED BOOK 2017 WITH PMBOK AND PRINCE2 CHANGE CONTROL PROCESSES

3.7.1. COMPARING MANAGEMENT OF CHANGES UNDER THE FIDIC RED BOOK 2017 AND THE PMBOK

As presented in section 2.4.4, the PMBOK expects that a Change Management Plan is developed and implemented and the Construction Extension to the PMBOK, as presented in section 3.3.1, foresees stages for Change Control.

Below, the author compares the PMBOK’s best practice guidelines with the process under the FIDIC Red Book 2017, see tables 2 and 3 and 4.

Table 2 – Comparison between PMBOK Requirements and the FIDIC Red Book 2017

PMBOK’s Change Management Plan	Provisions under the FIDIC Red Book 2017
Establish the roles and responsibilities to perform the Integrated Change Control	The roles and responsibilities are assigned to the Employer, the Contractor and the Engineer; however who specifically is authorized by the Employer is not defined or required to be defined
Establish who has the authority and/or how someone is authorized to perform Change Control roles	The Engineer is named in the Contract, and it must nominate the persons authorized to perform the role on the Engineer’s behalf
Establish the process for initiating, submitting and processing Changes	The process presented above is clear, establishing the entity and timings to perform each stage
Establish the process for evaluating Changes impacts	Variations may cause time and cost impacts, however it does not establish the process to evaluate impacts The Parties to the Contract, especially the Contractor and the Engineer are expected to have the necessary technical skills to evaluate
Establish the process for approving Changes	The approval process is either by Parties agreement or Engineer’s determination. It also provides the Parties a way to dispute if they disagree with the Engineer’s decision
Establish the process for implementing Changes on the project	Construction Projects may be severely impacted by time to take decisions, therefore the FIDIC Red Book 2017 establishes that if the instruction is given, the Contractor must start its execution In this point it takes into consideration the Engineer’s professional responsibility to take such instruction and provides the Contractor specific mechanisms to object
Establish the communicating process along the Change lifecycle	It is established by the requirements for each Party to notify each other at each step

It is relevant to refer that the FIDIC Red Book 2017 does not require define or requires the parties to define any standard regarding evaluation of variations. Of course the parties may elect to include any such industry specific standards and best practices regarding evaluation.

Table 3 – Comparison between PMBoK Change Control and the FIDIC Red Book 2017

Change Control characteristics under the PMBoK	Provision under the FIDIC Red Book 2017
Occurs throughout the project	Allows for changes to occur from the start of the contract until the Taking-Over Certificate is issued [27]
It may involve a change request to initiate the change	The initiation of the process is clearly identified
It is the only way to change the project management plan once the project is baselined	Does not allow for any Party to change the contract except through the Variation Procedure
Includes reviewing and approving changes and scheduling its implementation	It is part of the process as presented in figure 9
Delivers as output the approved change request	Binds the Parties to the agreed variation or Engineer’s determination, becoming part of the contract

Table 4 – Comparison between the Intent of Change Control under the Construction Extension and the FIDIC Red Book 2017

Intent of Change Control under the Construction Extension	Provision under the FIDIC Red Book 2017
Identify possible changes	Construction professionals are expected to identify changes
Review change regarding its impact on project scope, cost, schedule, and work activities in terms of quality and safety	A review process is expected to occur, but no specific process is defined
Notify the Employer in accordance with procedures and time requirements	Notification occurs at each step of the process
Process the change request as per the contract documents and ensure that a proper project record is made of the disposition for a change	The FIDIC Red Book is a contract document itself, with clear direction regarding required communication

The comparisons in the tables above confirm that the provisions of the FIDIC Red Book 2017 are in line with the best practices of the PMBoK Guide and its Construction Extension, except for points discussed in section 3.7.3.

3.7.2. COMPARING MANAGEMENT OF CHANGES UNDER FIDIC RED BOOK 2017 AND PRINCE2

As presented in section 2.5.6, PRINCE2 foresees Change Control to be performed in five stages. Below the author compares those five stages with the process under the FIDIC Red Book 2017 process, see table 5.

Table 5 – Comparison between PRINCE2 Issue and Change Control Procedure and the FIDIC Red Book 2017

PRINCE2 Issue and Change Control Procedure	Provision under the FIDIC Red Book 2017
Capture Changes	There are no specific documents referred to regarding capturing the change. The Contractor is required to provide its assessment and impact analysis
Examine Changes, including requesting advice from the Project Board / Change Authority	This stage is in line with the Engineer’s review. Although it would be common for the Engineer to negotiate and discuss the matter with the Employer, such is not mandatory under the conditions
Propose Options	The determination process involves the Engineer’s mediation to attempt an agreement between the Parties. During this stage it would be expected for the Engineer to broker between options, discuss technical options / methods / etc. . . . with the Contractor
Decide on Change	There is a clear process. The Parties are expected to agree on the change and its impact, in case the parties fail to agree, the Engineer is to determine/decide
Implement Change	<p>Construction Projects may be severely impacted by time to take decisions, therefore the FIDIC Red Book 2017 establishes that if the instruction is given, the Contractor must start its execution</p> <p>It establishes that the Engineer’s is under the obligation to give such instruction and provides the Contractor specific mechanisms to object</p> <p>However it allows for the implementation to start prior to the change impacts being fully agreed or determined</p>

Therefore, except for the implementation stage, the FIDIC Red Book 2017 follows the process structure foreseen by PRINCE2.

3.7.3. AUTHOR'S COMMENTS REGARDING THE DIFFERENCES BETWEEN FIDIC RED BOOK 2017 AND THE PROJECT MANAGEMENT STANDARDS

There are a few clear differences between the FIDIC Red Book 2017 and the Project Management standards presented. In the FIDIC Red Book 2017:

- The Contractor may be required to start executing the Change to the Works before its impact is agreed / approved by the Parties;
- There is no specific process for evaluating Changes Impact, only that the Contractor must present time and cost impacts and the Engineer must review the presented impacts and, if necessary, do its own evaluation of impacts;
- There are no forms/templates proposed or foreseen regarding recording and capturing the stages of the process.

The FIDIC Red Book 2017 is a contract and should not be expected to provide project management tools and templates. Such requirements may be imposed by the Employer as part of its contract documents and/or requirements, or may be proposed by the Contractor as part of its offer, or may be proposed by the Engineer as the “de facto” project manager.

However, it would not harm if there were recommend templates or a list of documents expected to exist for tracking purposes, which could be used by the Parties if they so wished. Employers may not be construction experts, and may not have templates to monitor the Engineer and Contractor.

On the matter of a specific process for change evaluation, there may be constraints either from the Employer, or from the law governing the contract. In the author's view it would be preferable that the Contract Data had a section leading the parties to agree on a process for evaluation of time and cost impacts of changes and claims.

On the matter that the implementation of the change may start before an agreement or decision on its impacts, it should be avoided. However, if it was no possible to force a change to be executed before the detailed assessment or approval, it would allow for ill-intended Contractors to delay changes indefinitely and cause serious delays and impacts on the project.

For that reason, and to resolve other issues the FIDIC Red Book 2017, drafters introduced new clauses which provide for checks and balances regarding managing changes. These clauses are presented and commented below.

3.8. AUTHOR'S COMMENTS ON FIDIC RED BOOK 2017 NEW PROVISIONS REGARDING CHANGE MANAGEMENT

The tens of experts involved in the revision of the FIDIC suite of contracts addressed several issues regarding misuse of the FIDIC Red Book 1999's change control process and adjusted clauses or introduced new ones to respond to the issues found.

When a new contract form is published, it takes time for the industry to adhere to it, or to adjust its own ad-hoc standard contract. However, in this case, the author's position is that the clauses introduced or adjusted in the FIDIC Red Book 2017 are significant, contribute to the risk sharing balance between Contractor and Owner, and avoid a number of black holes which allowed for parties to misuse the intended change control process.

Therefore, the industry's players should assess the specific changes introduced by the 2017 editions and take into consideration if such provisions should or not be introduced in their existing templates as particular conditions, and if so how.

On the next few sections, the author presents such clauses and its expected positive impact.

3.8.1. CONTRACTOR'S RIGHT TO OBJECT TO A VARIATION

In earlier versions of the FIDIC Red Book, the Employer's power to vary was open-ended, only eventually limited by any particular conditions or the underlying law [28], allowing the Employer to introduce changes of any type and nature, which could create unreasonable risks to the Contractor and the project.

The FIDIC Red Book 2017 provides express rights allowing Contractors' objection to changes. The first is the right to object to changes that are "Unforeseeable having regard to the scope and nature of the Works described in the Employer's Requirements." [18, Sub-Clause 13.3.1], meaning that if an Employer instructs a change that could not be reasonably foreseeable by an experienced contractor 28 days before the tender submission, a Contractor can object to it.

In his professional career, the author has experienced several changes which would be precluded by such clause. From time to time, Owners take advantage of an ongoing contract to introduce changes for different types of works which are not of the type contracted, for works which are not in the area of the contract, or other situations which disturb the Contractor's management of the work it was actually contracted to do.

In the author's view, this clause benefits both the Contractor and the Owner; it benefits the Contractor, allowing him to object to a variation which is likely to disrupt his management and the project. It protects the Owner from anyone who may have the power to change, from introducing scope which does not fit the Owner's requirements without any hold point, only for convenience.

Second, the Contractor may object to changes that may adversely affect his ability to comply with the obligations regarding health and safety and environmental protection. Third, the Contractor may object to a variation which [18, Sub-paragraph 13.1(e)] "may adversely affect the Contractor's obligation to complete the Works so that they shall be fit for the purpose(s) for which they are intended in accordance" with the documents of the Contract. This should mean that the Engineer may not issue an open ended instruction as a variation, if such change is significant, the Engineer should first required to change the contractual Employer's Requirements and/or documents forming the Contract.

The case study presented in section 4.4 is a clear demonstration of how the Employer's misuse of the power to vary can have dramatic consequences. The new clause under the FIDIC Red Book 2017 would at least give the Contractor a right to object to such change, that right could have avoided the consequences and impacts described.

3.8.2. ENGINEER'S OBLIGATION TO CONFIRM IF AN INSTRUCTION IS A VARIATION

Due to the impacts of changes, the open ended power to change is considered a major issue. The FIDIC Contracts Committee took into consideration that when issuing an instruction, the Engineer may not identify it, or part of it, as a Variation. In the earlier versions of the FIDIC Red Book, it would be difficult, and likely to amount to a breach, for the Contractor to refuse an Engineer's instruction unless he could demonstrate that a resource to execute the instruction was unavailable.

Furthermore, if the instruction was a variation, the Engineer would argue that an instruction had been given and that would be enough. A variation order was not required to bind the Contractor to start performing the Engineer's instruction, deeming the Contractor to be in breach if he did not comply with the instruction.

The FIDIC Red Book 2017 provides that, if the Contractor considers that the instruction is a variation and/or does not comply with applicable laws, the Contractor must immediately give notice to the Engineer before commencing the works. If the Engineer does not confirm, reverse or vary the instruction within seven days, such instruction is considered automatically revoked [18, Sub-clause 3.5].

In the author's view this is a major change, first because the Contract must give notice before commencing the works, meaning that such notice is intended to be immediate and to avoid a breach for not executing. Second, that Engineer only has seven days to act and if the instruction is indeed a variation the Engineer must express it and third that, as long as the Contractor issues the notice, the burden to act rests with the Engineer, failure to act revokes the instruction.

The author's understanding is that the intent of the FIDIC Contracts Committee is for changes not to be left floating, if an instruction is likely to be a variation, the Engineer must act and affirm it.

This is in line with the clause presented in section 3.8.1 protecting Contractor and Owner. This clause establishes that it is the Engineer's duty to name if an instruction is a variation, allowing the Contractor to give a notice and not advance with the works until the Engineer acts, likely to reduce situations in which Contractor and Employer are unprotected regarding the costs being incurred.

3.8.3. EMPLOYER'S LIABILITIES WHEN INSTRUCTING A VARIATION

Another fact demonstrative of the intent to limit the abuse of the power to vary is that the Contractor's obligation to submit a variation price proposal may allow the Contractor to present as costs any loss of profit, loss of any contract or any indirect or consequential loss or damage in connection with the contract [18, Sub-clause 13.3.1(c)].

This may protect the Contractor even when executing a legitimate change, which may have costs beyond the direct cost of the work itself, as would be the case of having to use resources which otherwise could have deployed more profitably elsewhere [28].

3.8.4. CONTRACTOR'S REQUIREMENT TO PROVIDE ALL NECESSARY INFORMATION PROMPTLY

Contractors usually complain about the long-time Employers take to give formal approval of variations, it is also common for Engineers and Employers to complain about Contractors' lack of care regarding submitting needed information to approve variations on time.

The author, managing project on behalf of a Contractor, attempted to maintain a fair and reasonable approach, claiming what is reasonable as per the contract, and accepting that the Contractor assumed several risks. However, throughout his career acting as consultant for Owners, the author has seen that most Contractors claim that any and every issue is a variation. Most of the times without detailed particulars, without contractual entitlement, simply because, in their view, it appears to be fair, or because of the not uncommon practice by Employer's to leave all settlement of changes to the end, where a purely commercial negotiation takes place on the overall value claimed.

It is common for endless periods to go by and an immense number of hours to be spent in meetings, without reaching any agreement, during which the Contractor is unwilling to put more effort to present the details as requested, while claiming that the Engineer has all that is required for the assessment,. In other cases the Engineer may in fact be not assessing because small minute details are not present.

The FIDIC Red Book 2017 addresses this matter by placing on the Engineer the requirement to request in due time all information required, and on the Contractor to provide that information. Time for the Engineer to present its determination only starts to run once all requested information has been received from the Contractor.

Therefore an Engineer who does not detail his request for full particulars of information, and/or actual costs, may be in breach, and a Contractor that, when requested, does not provide the information, is damaging itself since it cannot complain later that the Engineer has not replied in reasonable time.

In the author's view, this clause continues to depend on the good will of Contractor and Engineer, it does not refer what is reasonable to be requested. An uncooperative Engineer can probably delay indefinitely the date to provide a determination, frustrating a Contractor who may be acting in good faith.

Even if the Contractor provides all necessary details during the first 28 days, the timings from initiation of a change via an Engineer's instruction, from Contractor presenting details (28 days), to Engineer review and mediation of a Parties agreement (42 days) and an eventual Engineer's determination (42 days) may take almost four months.

Meaning, the Contractor may be executing works, without a final decision regarding time and/or cost impact, eventually financing such costs. Similarly, for the Owner time may be passing without surety of the impact of the change.

Other types of mechanisms could be preferable, namely allowing for variations to be resolved faster, and least a preliminary yes or no regarding entitlements for cost and/or time, allowing for all parties to have a quick way forward regarding manage the project's time, cost and financing impacts; and/or providing a preliminary fast track assessment, allowing the parties to have a baseline impact for the Contractor to be paid against; and/or establishing change monitoring and control mechanisms or templates which, if necessary, may later demonstrate who is the uncooperative party.

The case presented in section 5.3 is representative of normal situations in projects, in which only by the time a final hand-over and final account are required, the parties come to the table to discuss and bargain over tens of variations. This is not the intent of the FiDIC suite of contracts or of the best practices on project management.

3.8.5. OMISSION OF WORKS

The FIDIC Red Book 2017 establishes that the parties should agree on the omission of work and that the Contractor is entitled to propose an amount of compensation for loss of profit or other compensation for the omission.

This may be the way to resolve another common and, in the author's opinion, wrong practice. In order to simplify things and avoid managing changes appropriately, in some cases parties agree to do a work which is in fact a change, which is paid under contractual works that would otherwise be omitted. By establishing that when a work is to be omitted, the Contractor is entitled to compensation, Employers and Contractors should be motivated to achieve formal agreements and therefore appropriate change management, prior to incurring in costs to perform any works.

3.8.6. FINAL COMMENTS ON THE MANAGEMENT OF CHANGES UNDER THE FIDIC RED BOOK 2017

A change, subject to the contract conditions, may entitle the Contractor to additional cost and/or time or, may allow the Employer to reduce the time for completion or the contract value.

The drafters of the FIDIC Red Book 2017 have provided for a meticulous change control process, while attempting to mitigate the parties' misuse of the process. This is demonstrative that inappropriate change management and change control are seen as a major risk in construction projects and proper care should be taken while diverging from a proven standard form of contract or from a best practice.

Under the FIDIC Red Book 2017, the Engineer is supposed to be the fair and reasonable Project Manager, establish all tools for managing the change from start to finish, to have all technical competences to review and evaluate impacts, to mediate an agreement of the impacts between Contractor and Employer, and even to bind them to his determination if they cannot reach an agreement. However for the Engineer to properly perform his role, the Contractor and Employer must also abide by their obligations and facilitate such performance.

4

CASE STUDIES ON CHANGE MANAGEMENT PROCESSES IN LARGE CONSTRUCTION PROJECTS

4.1. INTRODUCTION

In the previous chapters, the author presented how project management best practices and international standard contract forms expect changes to be managed in construction projects.

However, throughout his career, due to the fact that the conditions of contract regarding managing changes were adjusted not taking into considerations the circumstances of the project, the author has regularly experienced, severe consequences to the Contractor, the Employer and generally to the project.

Case studies, from both successful and failed project issues, play a role on identifying best practices and provide learning opportunities [29]. This dissertation presents real life case studies, hopefully providing readers a clear understanding of some issues, of why Employers do not want for standard terms and/or best practices to be applied, or sometimes are not allowed by law, and what are the impacts of such decisions or legal requirements.

In section 3.2, the author briefly presents impacts of changes in construction projects of which the industry is aware. In this chapter, the author presents confirmation that the industry sees **inadequate change management as one of the major contributors to project failure**, followed by presenting case studies from projects managed by the author, from which the author deduces what may be causes for inadequate change management.

When presenting case studies, the structure is the following:

- Project Summary;
- Contract Conditions and Relevant Circumstances;
- Relevant Issue;
- Approach;
- Impact on the Project;
- Lessons Learned.

4.2. INADEQUATE MANAGEMENT OF CHANGES IS ONE OF THE MAIN CONTRIBUTORS TO PROJECT FAILURE

Project management best practices dedicate specific processes to planning change management and to change control. The industry's recognized international contracts, as is the FIDIC Red Book establishes specific processes, detailing who is responsible for each step of change control and how changes are processed within the contractual framework.

The construction industry has been aware for a long time that changes have a significant impact on a construction project's success, and that severe impacts occur if changes are not managed appropriately. However, often best practices are not followed and this knowledge area is not addressed as a priority.

In his 2014 thesis, Shahin Karimidorabati confirms that many papers have been published about the management of changes, however the number of papers focusing on the processes of change management is scarce [30] and today, project changes still constitute a major cause of delay, disruption, cost increases, poor quality and unsatisfying performance, and that **project changes are the main factor of litigation between Owners and Contractors** [30].

The Major Project Association (MPA) was established in 1989 for organisations engaged in the delivery and development of major projects, programmes and portfolios of any type. It held a seminar in November 2003 on Learning from Project Failures [31], in which it listed as the major reasons for project failure:

- Poor project definition;
- Unclear objectives;
- Unrealistic targets;
- **Inadequate risk evaluation;**
- **Client inexperience;**
- Poor forecasting of demand;
- Lack of an effective sponsor and strong leadership;
- Poor communication and lack of openness;
- **Inadequate stakeholder management;**
- Management focus wrongly targeted at the back end.

In KPMG's Global Construction Survey 2017 [32], construction executives expressed that, in the last thirty years the rate of construction project failure has not changed significantly, and the main reasons for project underperformance are:

- Wrong estimations and forecasts in planning and scheduling processes;
- **Bad contract management and acceptance of too much risk;**
- Incomplete scope definition, **scope creep and quantity growth**, along with the **inadequacy of change management processes.**

Taking his career into consideration, the author agrees with the above. Several of the points listed either contribute for inappropriate change management or are caused by it, deeming inadequate management of changes to be one of the main contributors for project failure.

It is bizarre that project underperformance and failure factors are known for decades, the industry's projects keep having the same issues, and the matter is not addressed. Although best practices keep evolving, it does not appear that the industry is learning, improving, and working to avoid the same issues. The MPA observed that these causes are known and unsurprising, and refers that organizations do not learn from project failure, because [31]:

- Organizations are not making good use of the tools available;
- Management or political pressures and other adverse interference may lead to unrealistic timescales;
- Organizations do not set up a “stormy” project delivery process, with detailed, agile plans;
- Organizations don’t listen to those on the front line;
- Organizations don’t understand the nature of organizational learning;
- Organizations don’t invest enough in team training and development.

The above can be said regarding inadequate change management, parties are aware that it is a major risk, it leads to project failure and often to disputes, and organizations do not focus on resolving the causes contributing for such inadequacy.

In this chapter, the author presents two case studies, proposes causes of why best practices are not fully applied by parties to construction contracts, examples of what successfully implemented, actions that failed and lessons learned proposing, what in his view, are improvements which could be implemented regarding change management in large construction projects.

4.3. CASE STUDY NO 01 – IMPLEMENTATION OF CHANGE CONTROL PROCESS IN ROMANIAN INFRASTRUCTURES PROJECTS

As presented in section 1.6, in 2008 the author was appointed to lead a contractor’s technical department in their Romania operation, providing technical and contractual support to the five ongoing projects. The contractor’s board requested for the author to support the project managers regarding contract and claims management, both through training and implementing processes.

Two of the projects supported were of major urban water and sewage networks in two Romanian cities, Galati and Pitesti. These projects were identified as high risk due to the nature of the work, site conditions and contract form. This case study focuses on the approach the author took, of providing specific training to the project management teams and implementing a process to control changes, towards safeguarding the contractor’s rights on the Drinking Water and Sewerage Network Rehabilitation Works for Galati.

4.3.1. PROJECT SUMMARY

The City of Galati is a district capital in eastern Romania, 246 km from Bucharest. It has hot and dry summers and frosty winters, the maximum recorded temperature was of 39°C and the minimum was of -28.6°C, the average number of frosty days during the year is 91.3, including an average of 41 days with snow cover.

The project scope included four segments:

- 11.2 km of rehabilitation of the main water network, including the connection to 25 existing well fields;
- 77.8 km of rehabilitation of the drinking water network in 18 city districts;
- 34.8 km of rehabilitation of the sewerage network along 47 roads;
- 24.9 km of expansion of the sewerage network along 48 roads;
- Including excavation and back-fill, remove surplus earth, replace existing pavements as well as intersecting other networks, rehabilitate manholes, improve accessible tunnels and clean non-accessible tunnels;

- Contractor only had to design solutions for the construction of pipelines under the tramway lines. The rest of the design had been performed by the Employer.

The project's Commencement Date was 11 March 2008 and the contractual Date of Completion was 10 June 2010.

4.3.2. CONTRACT CONDITIONS AND RELEVANT CIRCUMSTANCES

The project was financed by the Romanian Government and by the Instrument for Structural Policies for Pre-Accession (ISPA). Launched in 2000, ISPA was one of the European Union financial instruments assisting Romania in the preparation for accession, financing infrastructure projects in the fields of environment and transport [33]. There were regular checks by the European Union consultants to review the project status, including the contractual records.

Such projects funded by the European Union were contracted under the FIDIC Red Book 1999, adjusted as per the Romanian legislation in force. On the matter of Variations, Romanian Laws 10/1995 and 500/2002 required the inclusion of the following text at the end of Sub-Clause 3.1 Engineer's Duties and Authority:

“The Engineer shall obtain the specific approval of the Employer before taking action under the following Sub-Clauses of these Conditions:

... (c) Sub-Clause 13.1: Specific approval of the Employer is required before instructing or approving any Variation that would cause the Contract Price to exceed the Accepted Contract Amount or any contract amount subsequently agreed upon by the Employer and the Contractor in addenda to the Contract”.

4.3.3. RELEVANT ISSUE

The project was to be completed in 27 months, out of which 6 months were expected to be of frosty conditions. The scope was considerable, however the main challenge were the site conditions, working throughout urban roads, intersecting tens of other networks and utilities which the design had not considered due to lack of cadastral information, together with programming limitations imposed by a winter which forced a stop of part of the works for a considerable period.

As in almost all public infrastructure projects, the time for execution is presented in the tender documents and non-negotiable, imposed by the Employer, often motivated by political commitments to the population, and in this case with the additional pressure of the European funding conditions. Taking into consideration the site conditions, it was clear that the Employer's target regarding the project completion was unrealistic.

The FIDIC Red Book 1999 has the same definition of Variation as the 2017 version, which includes “changes to the levels, positions and/or dimensions of any item of work”, and/or “omission of work”. It also establishes that the “Contractor shall not make any alteration and/or modification of the Permanent Works, unless and until the Engineer instructs or approves a Variation” [18, Sub-clause 13.1]. As presented above, in this contract, the Engineer was not allowed to change the Contract Amount.

Therefore, in a project for which the design would have to be adapted to the site conditions in each road, and that any such change is by definition a variation, for any adjustment on site:

- The Contractor was contractually required to obtain an Engineer's instruction;
- Such changes required the parties to agree and record the solution, preparation of drawings, in the case of sewage, the adjustment of levels could cause further design changes downstream, etc.;
- If such instruction would increase the Contract Amount, the Engineer could not issue it without Employer approval;
- The Contractor and the Engineer were not responsible for design;
- The process for Employer approval of a variation changing the Contract Amount, as is normal for a public entity, was to amend the contract; which in this case required European Union validation.

Taking into consideration the above process, it was natural that the time to contractually process any significant adjustment to design due to site conditions would cause significant delays to the project, or at least force unreasonable waiting times of stoppage and restart of works.

Due to the unrealistic execution period and the expected political pressure arising from any project delay, the author was requested by the contractor's board to assess contractual risks and how to mitigate them.

4.3.4. APPROACH

The author's assessment included, first evaluating the type of risks the Contractor was exposed to, second assessing the project manager's knowledge regarding the contract conditions, and on how to record each type of event, considering that there would be hundreds of events.

The risk assessment lead the author to develop and implement a project specific contractual change and claims process, which was successfully executed by the project manager, allowing the Contractor to recover its costs due to delay events, and receive praises from the European Union inspectors for the quality and detail of the records, allowing the inspectors to fully understand the events and issues causing the delays.

4.3.4.1. Evaluating the Contractor's contractual risk

A reasonable Contractor takes into consideration the site conditions when submitting an offer, all the facts presented above were known at tender stage. So, wasn't therefore reasonable that the Contractor had allowed for the cost, time and resources necessary to perform the contract, taking into consideration all conditions?

In the author's opinion no, it is not reasonable to consider that such allowances are included in the Contractor's offer. Parties should negotiate in good faith, and in this case, the Employer is aware that a Contractor is submitting its offer in a competitive bidding process, for a construction only scope. If the Contractor would establish such allowances, it would have no chance to be awarded the contract.

The Employer decided to tender the project under a "design by the Employer" contract, deeming the Employer responsible for the adequacy of the design and for the contract conditions it is offering to Contractors. A reasonable Contractor would not have considered that an unmeasurable risk caused by unknown site conditions in a design by the Employer's contract would be Contractors' risk.

4.3.4.2. On the Project Manager's knowledge of the contractual mechanisms

In Portugal, the normal professional path for a project manager of construction projects is to become a site engineer after completing a civil engineering degree or masters. There are no degrees or specialization on project management, and there are no education providers offering courses in quantity surveying, or contractual and commercial management.

It is uncommon for Portuguese Contractors to have in-house contract management teams, directly supporting projects. The Portuguese construction industry has not established such requirement and there is little training directed to such knowledge areas.

A Project Manager is responsible to assess his team's training needs and develop the team, in the same manner any company needs to assess the training needs of the project manager, contributing positively for his success is to contribute for the success of the project and ultimately of the company.

In his drive to develop, the author has attended trainings on project management and has invested considerable personal time in developing contract management knowledge, culminating by obtaining his Master in Laws.

When initiating the support to the project, the author discussed with the project manager, Mr. Silva Abrantes, and together they performed a risk assessment with specific discussions on the risks, opportunities, and eventual impacts caused by lack of control regarding changes. It was agreed that the author would provide specific training to the project team on variations and claims under the FIDIC Red Book 1999.

The objectives of the training were for the project management team to be able to:

- Identify the contractual clause to refer to when giving notices to the Engineer;
- Know the minimum on the details required to support a variation and records for an eventual future claim;
- Know the steps from the first notice to the submission of the detailed particulars;
- Know what to include in the particulars for a variation and for a claim.

As in any project, the Contractor's project manager is responsible for at least to set up the processes to guarantee the rights to variations and claims are not contractually barred.

Still today the author is regularly faced with Contractors who fail to present notices in time and as per the contract conditions, that do not refer to any contractual clause when giving notice, that do not express their clear intent when submitting a notice, and that by not acting as per the contract, expose themselves to lose rights and/or having prevented the Employer to take actions to minimize costs or time impacts.

The training delivered in Romania provided a basic understanding on how to support variations and claims. However, as usually happens, the project team was being mobilized in short notice and the Contractor did not have specific processes or tools to manage the significant amount of changes which it knew would come.

The tool developed by the author in Microsoft Excel, allowed for the prompt issuing of notices, communicating in line with the contract conditions and for changes to be tracked. The typical files and process are presented below.

4.3.4.3. On the process developed and implemented

The author took into consideration the nature and conditions of the project, the FIDIC Red Book 1999 and developed templates for:

- Notice in accordance with Sub-clause 1.9 requesting drawings and/or instruction from the Engineer;
- Notice in accordance with Sub-clause 3.3 recording any instruction/documents given by the Engineer and, if it was the case, recording that in the Contractor’s opinion the instruction was a Variation and requesting the Engineer to issue the Variation Order according with Sub-clause 13.1;
- Notice in accordance with Sub-clause 4.12 recording that unforeseen physical conditions were found and giving reasons why it may cause disruption;
- Proposal for variation under Sub-clause 13.3;
- Notice of Contractor’s intention to Claim under Sub-clause 20.1;
- Logs to track Engineer’s replies to all of the above.

The tool comprised of five files, one for each notice, as shown in the image below, see figure 10.

Name	Type
1.9 Delayed Drawings or Instructions (R1)	Microsoft Excel 97-2003 ..
3.3 Instructions from the Engineer (R1)	Microsoft Excel 97-2003 ..
4.12 Unforeseeable Physical Conditions (R2)	Microsoft Excel 97-2003 ..
13.3 Proposed Variations (R2)	Microsoft Excel 97-2003 ..
20.1 Intention to Claim (R4)	Microsoft Excel 97-2003 ..

Fig.10 – Microsoft Excel Files part of the tool created

Each of these files has a similar structure, three worksheets; the first (Log) is the registry where all notices are logged and serves as the tracker, the second (Notice) is the notice template that will be issued to the Engineer and the third is the data filling sheet, see figure 11.

38	30				
39	31				
40	32				
41	33				

Log Notice Data

Fig.11 – Microsoft Excel tool typical file

The worksheets work with the Vlookup formula. The user fills the data on the Data worksheet, and by entering the number of the notice in the template, the data is ‘called’ by the Vlookup formula into each of the cells required to be filled. The Log worksheet also picks up information from the Data worksheet; the actual dates when documents are issued and received need to be recorded individually for each notice.

All files work in a similar manner, the author presents in figure 12 the template for the notice to record instructions from the Engineer under Sub-clause 3.3, and the corresponding tracking registry in figure 13.

DRINKING WATER AND SEWERAGE NETWORK REHABILITATION WORKS FROM GALATI

Instructions from the Engineer Notice

SENDER DATA/DATE EXPEDITOR		RECEIVER DATA/DATE DESTINATAR	
NAME/NUME		NAME/NUME	
COMPANY/SOCIETATE		COMPANY/SOCIETATE	
ADDRESS/ADRESA		ADDRESS/ADRESA	
TEL/TEL.		TEL/TEL.	

ISSUED BY / EMIS DE		DATE / DATA	
PDR / PENTRU		NP / NIL	3
REF. / REF.			
SCOPE / SCOP			

Dear

Following your instruction, in accordance with clause 3.3 of the Conditions of Contract, we hereby inform that:

The instruction given by (Name)		
The instruction was given in (Date)		
The instruction was given at (Place, Meeting, Other)		
We received the following instruction		
We received the following drawings		
We received the other documents listed		
We consider that this instruction constitutes a Variation	<input checked="" type="radio"/> YES <input type="radio"/> NO	
Documents in Appendix		

We kindly request you to issue to us the Variation Request/Order regarding the works described above. Without your instruction or approval, according with clause 13.1, we cannot alter or modify the contract's permanent works.

Yours faithfully,

ISSUER NAME AND SIGNATURE SEMNATURA EMITENT	
DATE/ DATA	

RECEIVER NAME AND SIGNATURE SEMNATURA DESTINATAR	
DATE/ DATA	

Fig.12 – Template Form of Notice to record Instructions from the Engineer

By requiring each of the lines to be filled, the Contractor is ‘forced’ to address each of the contract’s requirements. In this specific case, if the Contractor considers the Engineer’s instruction is a variation, the form serves as a notice and requests the Engineer to issue the variation. As presented under section 3.8, if the Contract was under the FIDIC Red Book 2017, this Contractor’s notice would require the Engineer to answer it in seven days, failing to do so would revoke the instruction.

On the matter of control and monitor the status of the notices replying to Instructions from the Engineer, the log is presented in figure 13.

DRINKING WATER AND SEWERAGE NETWORK REHABILITATION WORKS FROM GALATI

Log of Instructions from the Engineer Notices

	SCOPE	INSTRUCTION RECEIVED DATE	INSTRUCTION ISSUED BY	NOTICE SENT DATE	INSTRUCTION DESCRIPTION	VARIATION (Y/N)	VARIATION REQUEST FROM ENGINEER RECEIVED AT (DATE)
1							
2							
3							
4							
5							
6							
7							
8							

Fig.13 – Log to record Instructions from the Engineer

To avoid tempering with the Log the cells with blue headings were protected, the only column open to be edited had the brown heading, to input when the variation request had been received. At any moment, any party could see the status of the instructions issued by the Engineer.

In the author’s view, the tool has four main advantages:

- It addresses the contractual requirements, mitigating the risk of an invalid notice;
- Its direct approach is easier and faster to complete than drafting a letter;
- It is automatically recorded and logged;
- It can be tracked regarding open and closed issues.

4.3.5. IMPACT ON THE PROJECT

The implementation of such tool could have been understood by the Engineer and Employer as coming from a Contractor who was claim/dispute driven, in reality it had the opposite effect.

The templates were in line with the contract requirements, the Contractor was demonstrating its entitlement and keeping effective records, which could be properly evaluated by the Engineer.

The Engineer appreciated that the Contractor had a tracking tool that he himself did not have, facilitating the Engineer’s duties. The Employer was able to understand what the project issues were and avoid some of the mistakes in similar projects.

As presented in section 4.3.3, if the contract was complied with literally, the Contractor would have stopped every time the Engineer issued an instruction that would impact the contract value, waiting for the Engineer to obtain Employer approval of the Variation. In other cases, would stop waiting for the designer to validate the solution proposed by the Contractor and/or Engineer.

Throughout the project’s execution, when situations of the type of the previous paragraph occurred, the Contractor kept working at his risk, and issued claims. The Contractor was modifying the Permanent Works without an approved variation by the Engineer and therefore the Contractor became in breach of his obligations under the contract conditions.

This was done with the agreement of the Engineer, who rapidly understood that the entire project would be blocked if the Contractor was unwilling to keep working. The contract conditions in operation would block the entire project.

The Claims were evaluated by the Engineer and served as the basis for sets of variations to be prepared and approved through the long Employer's internal process, common to public entities. Once the variations were approved, the Contractor would notify its agreement and cancel the corresponding claims.

Such fact naturally had impact on the Contractor cash flow, however in this case the changes were limited to adjustments in levels, and a few more manholes in a few locations, its impact on the overall cost and financing budget was small and the Contractor could manage and was able to proceed with the works.

Of course the Parties may be considered to be under an implied obligation to cooperate and allow for the works to take place, however it is demonstrative how often Employers impose changes to the contractual conditions without fully assessing its impact. In this case even the Employer was forced to it, since it was a change to the conditions imposed by law.

4.3.6. LESSONS LEARNED

Taking into consideration the site conditions and project circumstances, it is the author's opinion that such type of project could be contracted under a "Design and Built" form and not a "design by the Employer" contract. A "Design and Build" contract would have allowed for the Contractor to re-design and proceed with works at his risk to deliver a fit for purpose infrastructure, obtaining support from the Engineer when required.

In a "design by the Employer" contract, a designer should be liable for the design, a Contractor for the construction of such design, an Engineer for the adequate management of the project and supervision of the Contractor, and the Employer for payments and ensuring the Engineer's duties are performed.

The site project management and construction supervision was there to manage the project as it had been designed and tendered, without responsibility over the design. If for any particular reason, the Employer wanted to keep control over the design, then it should have a design team present on site during the project, keeping the balance of parties' responsibilities and risks as intended by the contract conditions.

In the Galati project, the training and process developed and implemented by the author worked perfectly and supported the Contractor's intent not to lose entitlements. It is important to refer that the exact same process and templates were deployed in another similar project in Romania.

However in the second project the Contractor's project manager did not fully assess the risks and decided not to apply the process, maintaining the traditional approach to depend on good faith and believing what was being agreed would later be resolved and paid for, the reality was that the significant delays in the end of the project were not fully justified and the compensation for extension of time was not obtained.

The author also tried to implement this process in Oman, where it is common that Engineers take all the time they want to reply, many times against the contract's intent. In the project in Oman, the Engineer realized that the process and logs would show all such shortcomings, triggering the Engineer to request to the Employer to prohibit such templates. The Contractor had to adapt the templates and give notices and record issues in a less efficient way.

These two events allow lessons to be learned: first, that project managers on large and complex construction projects must possess specific skills and capacities, including a global knowledge of all aspects which need to be managed, especially risk management. This subject is detailed in section 5.2.; second, the importance of stakeholder management, especially in a new market, in the case of Oman, Engineers were used to ill intended Contractors who issued notices for claims with or without proper substantiation, there was little contract management awareness and the process' advantages were not explained to all parties prior to its implementation.

An important aspect is to demystify the misconception that to fully comply with contract notification requirements one must have a significant amount of resources and systems in place. The tools presented above were maintained by one person full time, in a project that issued tens of each type of notices.

4.4. CASE STUDY NO 02 – SEVERE IMPACTS OF INADEQUATE CHANGE CONTROL PROCESSES AND MISUSE OF THE POWER TO VARY

In Chapter 3, the author referred that inadequate change management and control may have significant impacts, in some cases caused by contractual shortcomings, and in other events, by the misuse of the power to vary. This case study covers three different situations:

- How the abuse of the power to vary may damage the parties to a project;
- How a project may fail due to the Engineer lack of power to vary and consequential delay caused by the Employer's changes approval process; and
- How variation may severely impact the Contractor's cash flow and the project.

4.4.1. PROJECT SUMMARY

In December 2009 the author moved to the Sultanate of Oman to the first significant project a Portuguese contractor was awarded in the Middle East.

Muscat, for many years, grew without a sewage network built into its road network. Each house has its septic tank, were sludge accumulates and is removed from time to time by a tanker. The tanker would then transport the sludge to one of the city's the sewage treatment plants. In 2009 this was still the case for most of the city. MonteAdriano was awarded the package for the execution of the sewage network in Al Khuwair, one of the densest residential areas of Muscat.

The Muscat Wastewater Scheme Project Contract No. 3 Bausher Network – Al Khuwair Network was a major project and its scope included:

- 37.8 km of Sewage Main lines network;
- 193 km of sewage connections from houses to main lines network;
- Building provisions to connect 7482 individual houses/plots to the new network;
- Rehabilitation of old sewage lines, installed 30 years earlier and never used, comprising of 7 km of relining, 5.4km of upsizing and 4.5 km of replacement of sewage networks;
- 8.3 km of irrigation treated sewage effluent main lines network; and
- Over 200 km of fibre optics networks.

The project's Commencement Date was 01 February 2010.

4.4.2. CONTRACT CONDITIONS AND RELEVANT CIRCUMSTANCES

In 2009, Infrastructure projects in Oman were governed by the Sultanate of Oman Standard Documents for Building & Civil Engineering Works (Fourth Arabic Edition) September 1999, based on the FIDIC Red Book fourth edition from 1987.

One key feature of the FIDIC Red Book fourth edition form was the power of the Engineer to make quasi-judicial independent judgements, which were commonly being challenged either by Contractors or Employers, leading to a significant number of cases ending in Arbitration [34, Preface page iii].

In this specific project, the Omani Employer did not change the general conditions; however, when issuing its delegation of authority to the Engineer, the Employer limited it and did not delegate the right to vary. Any change would require the Employer's approval.

Although the result regarding operation of the contract is similar to what was presented above regarding the introduction of particular conditions due to the Romanian law, this action is slightly different.

In reality the Contractor submitted an offer considering the contractual process would be one, and then, post contract signature, the Employer imposed limitations when delegating its authority to the Engineer. The Contractor is confronted with a different operation of the agreement regarding the powers of the Engineer to what it expected during the bidding process.

From that moment onwards, the Contractor no longer knows who has the power to approve changes impacting the Time for Completion and/or the Contract Amount. It knows the power was not delegated, however it is unaware of the Employer's internal process.

The Omani standard contract conditions include another limitation, if variations would change the contract amount in more than 10%, the contract must be amended. Regarding changes, being a public contract, amendments to the contract had to be approved by the Government Tender Board, a supervising entity of the public money expenditures.

4.4.3. ISSUE NO. 01 – MISUSE OF THE POWER TO VARY

The first issue refers to the misuse of the power to vary. Within two weeks of the start of the project, the Engineer issues a letter instructing the Contractor to change the main sewage lines from its designed paths into two wadis within the project area. Wadis are dry river beds which only have running water when it rains. In the case of Muscat, flash floods in some wadis are common when it rains.

The change of the lines to the wadis would improve the future expansion of the sewage lines, and it would omit deep excavations in the centre of Al Khuwair, which would likely reduce the construction period of the main lines because, however it was a major change as per the contract as it would:

- Significantly change quantities of work;
- New types of work, including open excavation and micro tunnelling below the water table in wadis and work in wadis with flood risks;
- New pipe materials were required and would have to be imported;
- Total change of the scheme's concept, omitting pumping stations, connecting the areas to the wadis, requiring a totally different network, types of connection, over 70% of the design from tender would not be used and had to be redone;

- The change was over the 30% of the project value and would require an amendment of the contract;
- In Oman, due to the flood risks, works in wadis require specific insurance and specific permits from the Ministry of Water resources and Ministry of Environment, which were not in place because were not required for the original contractual scope;
- This change would impact the works from the start.

Furthermore, the Engineer did not provide any detail design for this change, instructing the Contractor to execute the change and to do the necessary adjustments on the shop drawings which the Engineer would then approve.

The Engineer had obtained the Employer's approval to instruct the Contractor accordingly, however the Engineer could not approve a variation of that magnitude since it required an amendment of the contract. Additionally, the Engineer had no responsibility for the design, and had advised the Employer that developing the design would be a major variation to the contract between Engineer and Employer.

In summary, the Contractor was given an instruction that was a variation. However, the variation itself was not instructed since it required approval by the Employer and, due to its value, by the Government Tender Board. The Engineer was not the designer and had no design liability, and there was no time to obtain a full design without suspending the works, therefore Employer and Engineer attempted for the Contractor to redesign the scheme without redoing any hydraulic calculation, leaving a void regarding design liability.

The specifics of the work in wadis are presented below. A section of one of the wadis which the Contractor was instructed to work in is marked below, see figure 14.

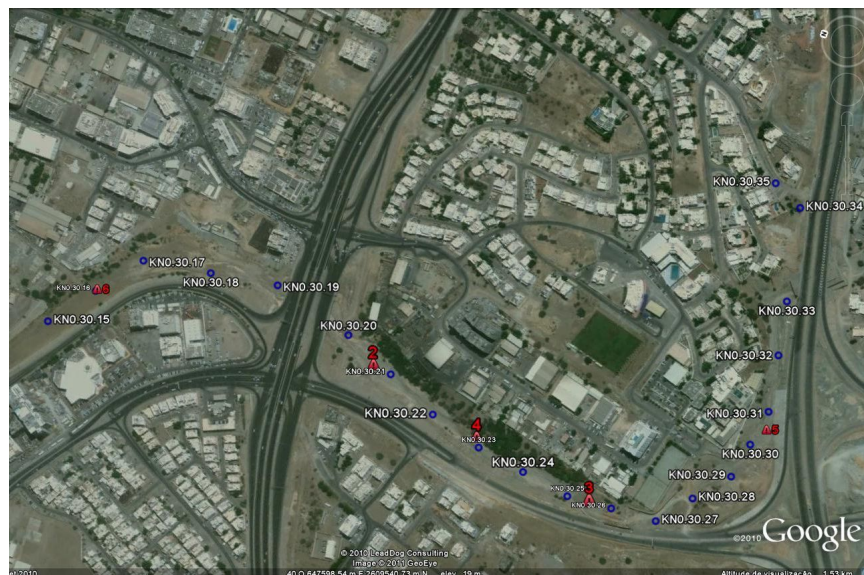


Fig.14 – Wadi where works were foreseen

The area is unconstrained, a photo taken as an initial survey after accesses were established is presented below, see figure 15.



Fig.15 – Wadi before start of works

However in a rain even you may have a flash flood, in this case specifically, due to the wadi's geography and geology, a short but strong rain event can cause a flash flood, requiring precautionary measures while working, as are not to keep any materials or equipment in the wadi when there is any chance of rain, see figure 16.



Fig.16 – Wadi after small rain event prior to start of any works

The works in the wadis started in 2012. In the week of 8 December 2012 there was a short but significant rain event which impacted directly the water line discharging to this wadi, the result on the works is presented below, see figures 17 and 18.



Fig.17 – Wadi after rain event in 08/12/2012



Fig.18 – Wadi four days after the significant rain event after the start of work

4.4.4. APPROACH TO ISSUE NO. 01

When it received the instruction, the Contractor immediately replied that such change would be a significantly variation to the contract's scope, requiring an amendment to the contract. The Contractor had no design responsibility and required a full design, with similar detail to the tender design, and specific permits and insurance had to be obtained.

The Contractor advised that a full risk assessment had to be made, the awarded scope had no work in wadis except for two minor crossings (under 100m in total) above the water table level, for which connections were not detailed. The Engineer's instruction was for over 8km of networks (sewage, irrigation and fibre optics) to be executed along the wadis.

The Contractor also proposed to be given the design as a variation, or to execute more works in tunnelling instead of open trench excavation below the water table, however the Engineer said that would simply have a higher cost.

As a last point brought forward the Contractor proposed the Employer to suspend the project to allow for the full redesign and assessment to take place. The Employer, as many public organizations, had multiannual budgets and development objectives and was unlikely to be able to address the political impacts of suspending the project just after the award.

The images above are demonstrative of the lack of awareness and risk assessment under which the instruction was issued. In the author's opinion, taking into consideration the execution and contractual risks to project, the Engineer should have alerted the Employer and alternatives to such an instruction should have been assessed.

The Contractor did not develop any shop drawings and/or design for the wadi lines or connections to it. However, in the spirit of cooperation and to allow himself to start the construction of what was work of the nature it had been awarded, the Contractor did develop shop drawings for the house connections section taking into consideration that the sewage would be drained into the wadis. Therefore from the start of construction of the house connection sections, the lines had to be connected to the wadis.

The Contractor fought as it could in order to obtain a full design and an amendment to the contract. The wadi lines design was finally produced by the Engineer and the work commenced almost eighteen months after the initial instruction with clear written Engineer's instructions to advance with the work.

On the formal variation order, it never materialized. The Engineer insisted that it had given an instruction which bound the Contractor to comply with it.

4.4.5. IMPACT ON THE PROJECT OF ISSUE NO. 01

The obvious impacts include the time delay, disruption of the Contractor's mobilization and planning, and the damages to works and insurance claims due to the rain event presented above. The Engineer's instruction introduced a major change, which did not follow the contract's intent or process, and impacted the project from its start.

If a change over 10% of the contract amount can only be performed with a contract amendment, which needs to be validated by the public supervisor, the author's opinion is that the standard contract form's intention is to minimize changes, adjustments are expected to be minor and not of this scale.

The contract actually required the Engineer to issue a variation order, however the Engineer would be in breach if it had done so, a change impacting the project in more than 10% required Employer's approval to be instructed and the Engineer had not been delegated the authority to issue such variation. In addition, the change did not depend only on the Employer. It involved a supervising entity, meaning that the Employer itself had no power to approve the variation by himself. In the author's opinion, the instruction should never have been issued.

The Contractor issued several warnings regarding the risks, proposed solutions, including suspending the works. The Engineer was who in the first place recommended the change to the Employer, everyone agreed it was an improvement for the future development of the scheme, however, the Engineer may have failed to alert the Employer to all the execution and contractual risks. The Engineer could not take any action without Employer's approval and had to follow the Employer's order to instruct the Contractor to do the changed works.

This contractual ‘black hole’ allowed for misapplication, the Contractor is bound by the instruction and cannot refuse to execute, the contract allows for this to avoid contractors from procrastinating and damaging employers. At the same time the Engineer is under an obligation to issue a variation which, in this case, is precluded to do.

If the Contractor does not start the work, it can be considered in breach, if he does start, he is in risk since there is no knowing if and when a variation is approved and issued, and until then, such works are unlikely to be paid.

Although, as referred in section 3.8, the FIDIC Red Book 2017 introduces the right for contractors to object to a variation and a requirement for the Engineer to confirm a variation, in light of what the author has seen time and time again, the Contractor should be also able to object when a change depends on the Employer approval, or on a third party, and such approval process is not presented and agreed to.

Education on change management and associated risk assessment is of major importance; this was presented in the previous section and is discussed further in section 5.2. Employers and Engineers need to allow for open discussions regarding change approval processes and its impacts, and not simply issue instructions and then see what happens. In the case presented above, the ‘see what happens’ approach deemed the project to failure.

4.4.6. ISSUE NO. 02 – IMPACT OF CHANGES ON CONTRACTOR’S CASH FLOW

This second issue refers to the subject introduced in section 3.4.3, the impact of inadequate change management on the project’s financial management, in this case the Contractor’s.

4.4.6.1. Preliminary Notes on Managing Cash Flow

Today’s project manager must understand the basics of project financing. When on the Employer’s side, this may refer to financial instruments and/or project specific finance, on the Contractor’s this could be managing cash flows, price fixing, hedging, and basics of accounting regarding receivables and payables periods, accrued revenue and production, and other accounting aspects which are not the subject of this dissertation.

For the matter of this dissertation, taking into consideration students or professionals who have not been exposed to this knowledge area, the author must refer that in construction, managing cash flow is one of the project manager’s most important tasks. Even if the day to day or short term management of cash flow is performed by accounting departments, cash flow forecasting must be performed and monitored by the project manager.

Any business requires time in advance to obtain funds, and if the project manager does not raise awareness in time, it may not have the required funds to execute and deliver the project. Cash is a project resource and must be managed accordingly. In construction “Cash is King” [35].

Depending on the markets and/or Employers, a Contractor may receive an advance payment and/or have part of each payment retained for guarantee. An advance payment causes an initial positive impact on the cash flow, while retentions cause negative impacts over time only, usually only recovered in the end of the project.

Any increase in production costs has a negative impact, however increase of direct costs usually increases the project’s cash flow minimum absolute value, compounding with the effect of Employer’s

payments which usually have longer periods than the Contractor’s payments to its suppliers and sub-contractors. Any project delay causes the project overhead costs to accelerate expenditure.

At the start of this specific project, the author prepared a cash flow considering there would be a gap of 30 days between Contractor’s payments to suppliers and sub-contractors and Employer’s payments to Contractor, and developed three cash flow projected scenarios consisting of:

- Scenario 1 – the baseline program, direct and overhead costs and payment periods are complied with;
- Scenario 2 – the direct production costs are 10% higher than considered at offer stage;
- Scenario 3 – the project is delayed by 15% without compensation for costs incurred.

The author’s objective with these first rough calculations was to make its management aware of the cash flow needs, of the baseline (Scenario 1) and of feasible worst case scenarios. The scenarios are presented in figure 19 below. The values presented are not the real project values, however are proportional to the real values.

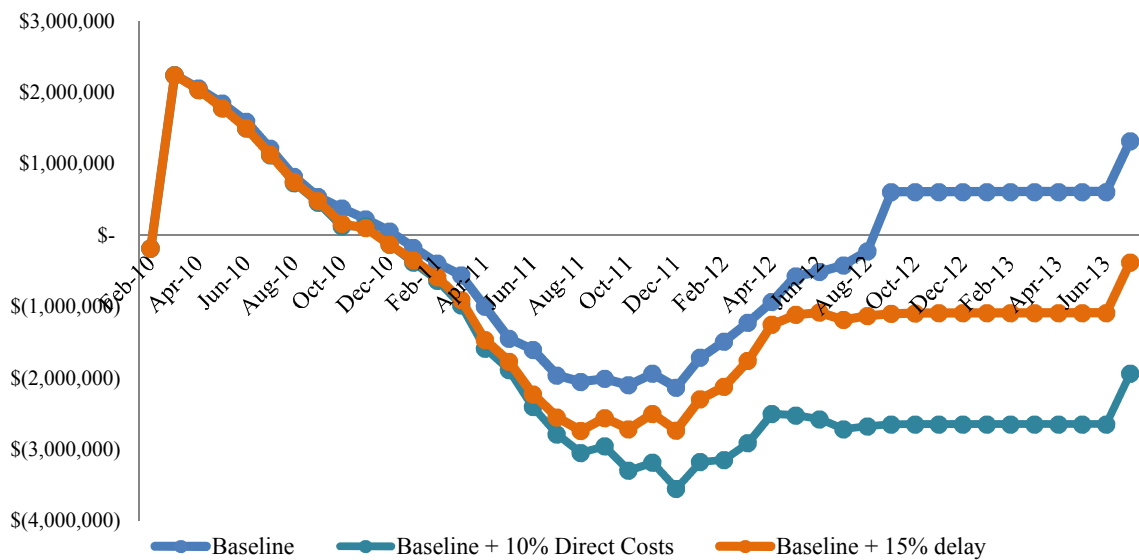


Fig.19 – Initial Cash flow scenarios

From the above graph it is evident that any of the considered worst case scenarios deem the project to end at a loss, however it also allows to conclude that in this project:

- Even the baseline graph shows the project would require financing beginning one year after the project’s start until the last month;
- Any direct cost increase has a dramatic effect, both on the project’s result but more importantly on the cash flow needs, a 10% increase on direct costs doubles the peak negative financing requirement (negative cash flow);
- A 15% delay to the execution increases the cash flow peak need by approximately 40%.

As presented in section 4.4.3, at the start of the project the Contractor was faced with a major problem caused by an Engineer’s instruction. The project manager immediately understands that this is likely to delay a significant part of the project, without mitigation actions this will impact its cash flow requirements in accordance with Scenario 3, or in a similar way. Even if later there would be an

extension of time and cost compensation, the Contractor would still have to finance the costs until compensated.

Furthermore, the project manager knows that any direct cost increase will not only impact profit but also cash flow, which would be further worsened if the Contractor is not paid because the variation is not approved.

4.6.6.2. On the Impact of the scope Change on the Cash Flow

When the Contractor received a design, and agreed rates for the variation works with the Engineer, its production had to start, requiring specific tunnelling pipes and caissons, mobilization of tunnelling and shaft sinking equipment and specialized teams.

Tunnelling is a work with a long lead regarding costs, even after negotiation, the time between expenditure and receivables for the variation works was longer than what was foreseen in the baseline, and the execution time was shorter, which would cause a severe peak regarding cash requirement.

Becoming aware that delays would occur and cash flow would be impacted, the author took actions to minimize the project's cash flow requirements by adjusting the type of production it would focus on.

4.4.7. APPROACH TO ISSUE NO. 02

At the start of the project, taking into consideration the initial cash flow requirements, and that the change instructed would delay the project production and worsen the financing requirements, the contractor's management requested measures to reduce the negative cash flow impact.

In order to reduce impact to the cash flow the author reduced the mobilization of the planned project overheads and replaced some equipment foreseen to be acquired by short term rented equipment, which could be released in case of delays in production.

During the project, the project management team continuously updated material ordering schedules to minimize long lead payments. There were significant procurement negotiations on payment terms and make versus buy decisions to reduce costs. The project management team was minimized in line with the production possible to deliver, not the production foreseen in the project's baselines.

All actions allowed the project to arrive at July 2012 without any financing except for the funds generated by the project itself. Active management of the project's financing allowed the project to work for two years, with less production than expected due to the change, with a positive cash flow.

When it was likely that there would be an agreement to advance with the variation works between the Contractor's management and the Employer, the author presented a report regarding the impact of such works on the cash flow requirements. Compensation for delay events was being discussed; therefore the author presented two cash flow scenarios, one with the delay events compensation and one without. Such scenarios are presented below, see figure 20.

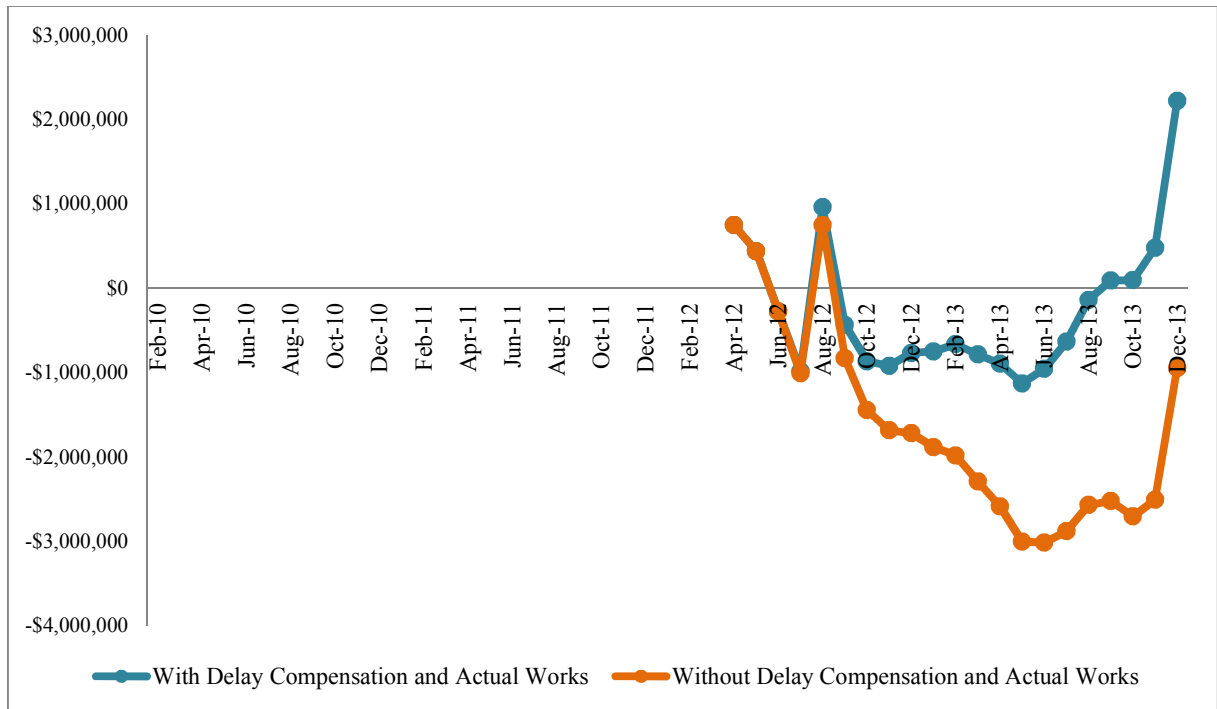


Fig.20 – Cash flow scenarios taking into consideration impact of executing changed works

The graph shows the significant impact that a major change, or a number of changes that amount to a significant value, may have on a Contractor’s cash flow. In this case, the final scope changing the main lines to the wadis represented approximately 20% of the project value. The main conclusions from the above graph are:

- The start of a new activity with a significant mobilization/lead costs would create a major need for cash; in the scale used, the cash flow goes from a positive 1 million monetary units (MU) to a negative 1 million MU in 3 months, meaning without additional advance payment the Contractor would have to directly finance the project in 2 million MU;
- If only the variation works would be paid and not the compensation for the extension of time, the cash flow requirements would go to negative 3 million MU after a few months and the project would never breakeven.

This allowed the Contractor’s management to assess the situation and discuss with the Employer the possible impacts. An additional advance was discussed but never materialized since it required again the third party supervisor approval.

4.4.8. LESSONS LEARNED

As presented, the misuse of the power to vary can be a major problem in construction. Employers and Engineers sometimes take the easy approach of instructing a change, stating that such instruction alone is sufficient to bind the Contractor, and assessments are to take place at a later date. The same can be said to Contractors who do not provide documents in time, leading to assessments being delayed.

The above positions are usually against the intent of standard contracts and usually in breach of the parties’ obligations, but also against the minimum cooperation between parties which may be implied in the performance of any construction contract.

Parties fail to understand that such actions or lack of action goes against themselves. Employers who do not properly assess changes and their impacts may end up with Contractors unwilling to support them and may be leading the projects into a dispute, and/or not finish the projects, as was the case above. Furthermore, may be causing impacts on themselves which have not been considered in the Employer's budget.

From the author's experience, the main contributor to this type of situations is the lack of risk management knowledge of the persons/entities involved, leading to instructions being made without a full assessment of the risks and impacts to the project, sometimes simply driven by political commitments, or internal unreasonable/unmanaged expectations.

In the case presented this is even made worse, by not delegating the power to vary, the Employer 'omitted' the Engineer's duty to instruct variations, however left the Engineer with the power to instruct the Contractor to do works, which may be variations, that not even the Employer could approve alone.

When taking actions which may impact the operation of the contract, Employers should assess risks in detail, and Engineers should act as a truly independent entity and advise the Employer of the risks it is taking.

Employers need to consider that by leaving the Engineer's duties untouched, the Engineer's liability is complete and can be enforced by Employers. If Employers change contracts conditions in a way that Engineer's duties are partially changed and/or omitted, Employers may be considered to have prevented the Engineer's ability to act and, therefore, have intended to limit the Engineer's liabilities.

On the matter of the variation impacts on the cash flow, the author made all reasonable alerts, attempted to find a way forward acceptable to the Engineer and Employer, and internally with the Contractor's board of directors. These different stakeholders had different motivations and risk assessment cultures.

Another fact, more common in public owned Employers, is that, in order not to appear biased, such Employers 'prefer' not to reach agreements, leaving matters to be resolved by arbitration [34, page iv]. Due to the timelines of arbitration, this lack of action is usually a major risk to the project, in particular if the issue/dispute has severe impacts on Contractor's cash flows.

In the project presented in this section, the only way forward found was one of excessive risk. The Employer wanted the main lines in the wadis which was technically better for future development of the network, however the decision to issue such an instruction was taken without fully assessing the impacts, and 'forced' a variation that the Employer himself did not have the authority to approve, nonetheless the instruction was issued.

Even if without intending to do so, the Employer mislead the Contractor regarding the status of approval of the variations by the supervising authority, the approval was taking longer than expected by all parties. The Employer was precluded to pay a significant part of the variation and of the Extension of Time compensation agreed between Contractor and Engineer, worsening the Contractor's cash flow position beyond what was forecasted.

The unreasonable cash position caused by the contract conditions, and almost inoperable change management process, left the Contractor without any other option but to stop all variation works and to initiate a dispute.

The Contractor's management cooperated and did not want to appear unsympathetic to an Employer, in particular in a first project in a new country. Such good faith caused the Contractor to continue working for longer than reasonable, hoping that the Employer would resolve the approvals.

In addition, if the Engineer had taken strong actions and/or presented risks that were against the Employer's wishes to change the networks into the wadis, such action could be perceived as resistance and cause difficulties to the Employer's position, eventually compromising the Engineer's major contract in Oman. However, by not assessing the overall impact of the variation on the project and to the Contractor, the Employer did not get a finished project.

In summary, the lessons learned from case study no. 02 include:

- It is never too much to refer the importance to train and develop have project managers' knowledge regarding change management, including risk assessment;
- The FIDIC Red Book 2017 clause allowing the Contractor to object to a variation should be implemented in all types of contract. If it existed in this contract it could have benefitted Employer and Contractor and avoided the above mentioned 'black-hole';
- In a major construction project, the contractual change management process should be clear to all parties at the start of the contract and not allowed to be changed or limited after the contract is signed, as was in this case by the delegation of authority; the entire process, including any Employer's internal approval process must be presented during the negotiation stage and its drafting must be unambiguous;
- Approval by the Employer is too vague. The contractual change management process should detail who (specific person, position or entity) has the authority to approve changes, and that lack of validation from that authority should allow the Engineer or the Contractor to reject an order to change;
- When it is evident that the Contractor is entitled to an extension of time or another compensatory event, there should be a provisional payment allowing the Contractor's cash flow not to be worsened. To safeguard any lack of entitlement, such payments could be secured by a Contractor's bond, which would be a cost effective solution, and would avoid putting the Contractor at risk of not being capable to finance the project;
- The Employer should require that a cash flow histogram is part of the contract, not only a production or value of works histogram. The Employer could also include a contractual requirement of allowable cash flow which the Contractor must have available. If or when Employers changes cause the allowable cash flow limit to be exceeded, the Contractor should be allowed to request the financing of the changes to be covered by the Employer;
- The Contractor's noncompliance with times required for submissions is common. In major projects, the cost of a project change management team would be insignificant when compared with impacts as seen above regarding costs, disputes and delays. A permanent change management team could be in place and solve on a daily basis problems regarding contract requirements, contributing to the assessment of contractual entitlements, mediating commercial aspects and providing an unbiased impact assessment that all parties may take into consideration.

5

CASE STUDIES ON PERFORMING CHANGE CONTROL IN LARGE CONSTRUCTION PROJECTS

5.1. INTRODUCTION

Chapter 4 presents case studies on issues and impacts arising from inadequate change management processes or misuse of such processes, where the author represented a Contractor. The lesson learned include that projects and parties can be severely impacted when the contractual change management processes are altered, and/or when the persons involved in performing change control do not possess the knowledge and skills to assess the impact of changes they may be instructing.

This is in line with the PMBoK Construction Extension's statement cited in section 3.4.2, that parties and/or persons involved in construction projects must have industry-recognized knowledge when assessing change impacts in order to avoid unwanted claims [23, page 61]. This aspect is detailed in this chapter as introduction to the case studies.

The case studies presented in this chapter focus on the performance of change control as Engineer / Employer Representative, reinforcing the importance of skills and specific knowledge to adequately perform change control, providing examples of shortcomings from the Contractor, Employer and Engineer, mostly due to the lack of adequate change management processes and skills.

5.2. IMPORTANT SKILLS FOR PROFESSIONALS MANAGING AND CONTROLLING CHANGES

In section 4.2 the author refers to the MPA's Learning from Project Failures seminar [31] listing, amongst others, the following common reasons for projects failure:

- Inadequate risk evaluation;
- Client inexperience;
- Poor communication and lack of openness;
- Inadequate stakeholder management.

The author also referred to the KPMG's Global Construction Survey 2017 [32], in which construction executives expressed that insufficient change management rigor and bad contract management are the main reasons for project underperformance.

The author's experience is that the industry's players do not implement specific training dedicated to change management and change control. The industry focuses on specializing people in management

of claims and disputes, insensible to the fact that a significant percentage of claims and disputes occur because of inadequate change management and could likely be avoided.

It could be expected that construction industry's companies and education providers would take into consideration the above, and try to resolve the cause instead of focusing with dealing with the consequences. Take the lead by implementing trainings to improve the change management knowledge and skills of their managers and technical staff, contributing for better change control performance. However, this is not what the author has experienced.

In order to address this issue, and prior to advancing to the case studies, the author presents:

- The skills which best practices recommend that project managers or anyone persons managing changes should have;
- “Must have” legal principles knowledge when assessing changes.

5.2.1. SKILLS RECOMMENDED BY BEST PRACTICES

As stated by the PMBoK, research has proven that “the top project managers consistently demonstrated several key skills” including the ability to focus on the critical technical project management elements and the project's critical success factors [2, page 58].

Furthermore, the PMBoK refers that qualities of a leader include “focusing on important things including differentiating high level strategic priorities, especially those related to critical success factors for the project” [2, page 62].

As referred in section 3.4, **the only project critical success factor referred in the Construction extension of the PMBoK, is the existence and implementation of an integrated Change Management Plan.**

“Project Integration Management is the specific responsibility of the project manager and it cannot be delegated or transferred [2, page 119], therefore the project manager is expected to take the lead and have the skill to perform and/or coordinate the performance of Integrated Change Control himself.

Performing Integrated Change Control includes applying tools which identify, document, decide, track and communicate all changes [2, page 119], and promoting meetings between the individuals responsible to Perform Integrated Change Control. It is inferred that, depending on the project and status of change control, such meetings may be ad-hoc, or standing and regular.

The PMBoK states that performing Integrated Change Control involves applying expert judgement by individuals knowledgeable and/or trained in [2, page 118]:

- The industry / focus area of the project;
- Legislation and regulations;
- Legal and procurement;
- Configuration management;
- Risk management.

The author concludes that on the matter of the project manager's role in construction projects, the PMBoK expects the project manager to lead change management and the performance of Integrated Change Control, to be knowledgeable and possess the necessary skills to manage such project critical success factor, which include less common subjects.

5.2.2. INTRODUCTION TO 'MUST KNOW' LEGAL PRINCIPLES WHEN ASSESSING CHANGES

Regarding the five items listed above which the PMBoK expects anyone performing change control to be knowledgeable of, one is legal and procurement. The author has experienced a significant number of situations in which, individuals responsible to Perform Integrated Change Control, do not consider basic legal concepts while attempting to justify changes and entitlement. This is demonstrated in the case studies presented below, for now the author elaborates on two relevant legal principles.

Changes may be simple, as would be a change of one material for another or an increase of a quantity of work. However, other changes may be complex, require a detailed analysis and/or interpretation of the contract to demonstrate entitlement.

When evaluating if a specific event is contractually a change, or assessing the impacts of a change, one must take into consideration legal principles which are at the basis of any construction contract. The two principles that the author chooses to present are:

- The Principle of Party Autonomy; and
- The Prevention Principle.

5.2.2.1. The Principle of Party Autonomy

The Principle of Party Autonomy establishes that, except for limitation imposed by the contract's governing law, parties are free to choose the rights and obligations to include in their contract. When something is not expressed, the contract is usually to be interpreted taking into consideration the parties' intent at the time of the signature of the contract, that being the intent of a reasonable person of the same type and under the same conditions, taking into consideration the way the parties agreed for risk to be apportioned in their contract.

As an example, Sub-clause 4.11 of the FIDIC Red Book 2017 establishes that, by accepting the contract, the Contractor satisfied itself of the correctness and sufficiency of the contract value. This means the Contractor as agreed to a contract value while considering all reasonably available data, and confirms that the contract value is enough to comply with all obligations and properly executing all the Works in accordance with the Contract.

This is a wide reaching warranty and if the Contractor does not define in detail what he considered or not to perform the works, he may be prevented to recover significant values which could otherwise be considered changes.

Without limitations/qualifications, and/or a specific methodology, a reasonable Employer could only consider that the Contractor included everything required to perform the work. The assessment of this type of clause is of major importance for the preparation of the Contractor's offer and while assessing changes.

5.2.2.2. The Prevention Principle

The Prevention Principle establishes that a party to a contract cannot insist upon the performance of an obligation which he has prevented the other party from performing [36], meaning a party cannot benefit from its own breach of contract and/or benefit from an action or omission which damages the other party [37].

In the context of a construction contract, as an example, an Employer that does not provide information needed, or does not give an instruction, or does not approve a variation in due time, may be in breach and may be causing damages and/or delays to the Contractor, which may entitle the Contractor to a change, extension of time and/or recovery of damages.

Or, subject to the contract conditions, if the Contractor takes actions which impact the Employer, and does not inform the Employer in time for mitigation of such impacts, the Contractor may have prevented the Employer's reasonable actions and may be barred to recover costs incurred.

In case of a change, the party impacted usually has to prove that the change would have no impact 'but for' the action or omission of the other party.

In the rest of this chapter, the author presents case studies on different types of changes, refers back to the skills and principles presented above, and presents lessons learned.

5.3. CASE STUDY NO 03 – IMPACTS OF OMITTING THE ENGINEER'S POWER TO VARY AND DETERMINE

As referred in the previous chapter, Employers regularly develop ad-hoc contracts based on the FIDIC Red Book, or other FIDIC contract form, in which the Engineer's powers regarding approval and/or determining the impact of changes are usually omitted, and/or Employers keep the power to approve changes to the baseline cost, time and quality, either by their choosing or by legal imposition. The two case studies presented in the previous chapter are representative of this type of change.

The author's experience is that Employers, Engineers and Contractors do not fully understand the impact of these contract adjustments in the operation of the contract at the time of contract negotiation.

As referred by the author in section 3.8.4, it is not uncommon for projects to keep advancing and only by the time a final hand-over and a final account are required, the parties come to the table to discuss and bargain over tens of variations. By that time, it is also not uncommon that parties are at a pre-dispute stage.

This case study is representative of such situation, a project in which the contract was adjusted, altering the balance of powers regarding management of changes. The case study presents how such contract adjustment led to a standstill, deteriorating the relationship between all parties, delaying the final account and taking over, causing damages to Employer and Contractor.

The author presents the adjustments in an ad-hoc contract, the impacts, and actions he took to attempt resolving the standstill. In the lessons learned of this case the author presents, why in his opinion, the standard mechanism under the FIDIC Red Book 2017 defends Employer and Contractor and does provide more security to the Employer, instead of the risks taken by altering the contract and eventually causing the change management process to become inadequate.

5.3.1. PROJECT SUMMARY

In late 2016 the author was requested to support a project that was in its final stages. Works were substantially complete and the taking over process was overdue because the project's variations had not been agreed during the project's execution and were not determined to allow for a final account.

The Employer is a major property developer in the Middle East, the project included the execution of general infrastructures, establishing seaside land plots for residential and touristic development through a major landfill, dredging and reclamation, and coastal protections.

The project's commencement date was mid October 2014 and it was expected to be completed in 14 months. Due to several changes and delays regarding permits, most of the works had been completed by mid-2016, with a delay of 4 months; the Parties were not able to agree most of the variations entitlements at the appropriate time.

5.3.2. CONTRACT CONDITIONS AND RELEVANT CIRCUMSTANCES

The Employer had its own ad-hoc standard conditions based on FIDIC Red Book 1999 which were applied in all its projects, the conditions' adjustments relevant to change management are presented below.

The definition of "Costs" under the FIDIC Red Book 1999 impacts what is recoverable under variations [38, Sub-clause 13.3]. In this project's ad-hoc contract, "Costs" were all direct and reasonable expenditure necessarily incurred in connection with the execution of the Works, including Project specific overheads, but not including non-Project specific overheads, profit or loss of profit.

On the Variations and Adjustments clauses [38, Clause 13] the main adjustments included, transferring the power to instruct/request Variations from the Engineer's to the Employer's Representative, and that the Contractor was bound to execute such variations even in the event that Parties did not agree on the changes to the Contract Amount and/or Time for Completion.

The Employer's Representative, and not the Engineer, had the power to agree or determine variations and the Dispute Adjudication Board (DAB) was omitted from the contract, arbitration was the only available dispute resolution process. The contract also required that the Contractor's submission of variation particulars was in accordance with the Employer's Change Management process, however such process was not part of the contract documents or of the tender documents.

The Employer's Change Management process was complex and required the approval of several managers. This process's intention appears to be for the Employer to keep control regarding changes impacts, however in the author's opinion this process is unlikely to give the Employer more control, it causes the Employer higher costs to manage changes, more unknowns during the project, eventual lack of Contractor's cooperation and it is more likely to result in disputes.

In conclusion, the Engineer's powers regarding variations were striped. The Engineer was the record keeper and reviewer of the variations process, the Employer's Representative was the only person who could initiate and approve or determine variations, that is nor agreed to, would result in arbitration.

In the author's opinion, a process where the Employer's Representative becomes the only to initiate and determine variations, considerably changes the risk balance of the contract and exposes Employer and Contractor to unnecessary risks. There are noticeable differences under such process and under the process of the FIDIC Red Book 2017 presented in section 3.6.

The author must refer that the Employer's Representative was full time on the project, both him and his superiors acted in good faith, and the Employer was willing to pay any values the Contractor was entitled under the contract, however the layers of the approval process required several Employer's managers to confirm a decision, some managers did not knew the project's details or did not have the technical ability to understand the issues, causing stops and restarts to the approval of most variations.

The summarized process that was applicable in this project is presented below, see figure 21.

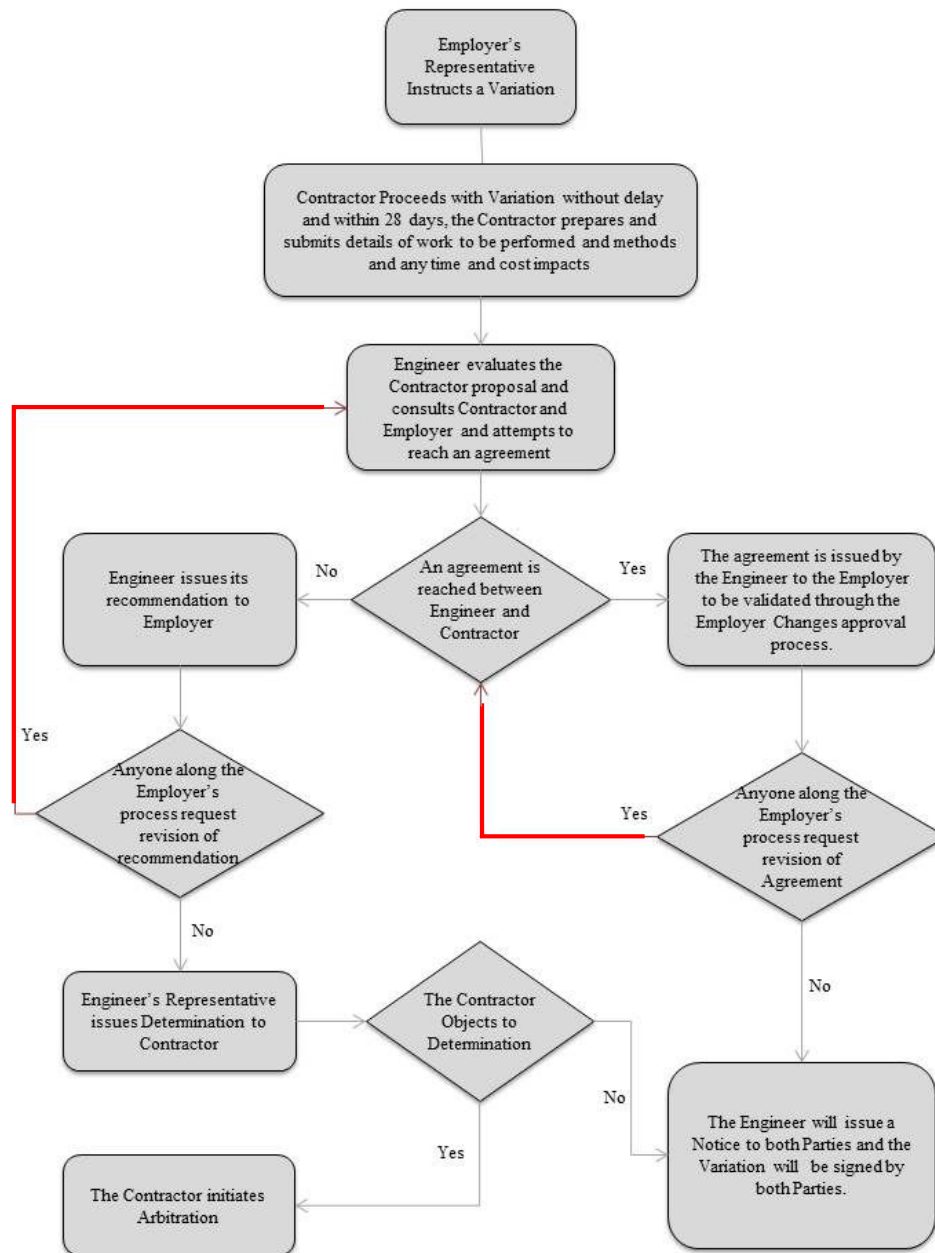


Fig.21 – General Variation Process under Case Study No. 03

Under this process, any time a level of approval within the Employer’s approval chain had a query or a doubt, or believed something could or should be further negotiated, the process was ‘restarted’, as demonstrated by the two above connectors marked in red. The Engineer had no real power to reach, what in his view may be, a fair and reasonable agreement or determination.

5.3.3. RELEVANT ISSUE

Under FIDIC Red Book 1999, when parties do not agree to a variation's cost or time impact, it is for the Engineer to determine. If any Party does not agree with such determination, a claim may be raised which will be determined by the Engineer. If the Party does not agree with the claim's determination, it can raise the matter to the DAB, and if it does not agree with the DAB's decision, it may initiate to arbitration [38, Sub-clause 20.6]. If by the end of the works, open claims still exist, such values will be referred to in the final account and either are agreed or settled through dispute resolution.

If the person, to whom the Engineer (firm) delegated duties, is not performing adequately, by not replying on time, or due to any other issue, the Contractor may request the Engineer (firm) to act. If the Engineer fails to act, the Contractor may request the Employer to act. The descriptions demonstrate that the FIDIC Red Book 1999 establishes clear rights and duties, while giving the parties several opportunities to appeal from what they may believe to be unfair.

In the project presented in this section, the particular conditions established that the Employer's Representative had the power to determine, and the Employer's internal approval process implied that the Employer's management had approved the variation and/or validated a determination.

In the author's opinion this caused two major issues: First, when an agreement is not reached, the Employer is not willing to issue a determination, since such determination is a 'judgment' likely to be the Employer's position in a future claim and/or dispute. The Employer is omitting the right to disagree with someone else's determination. Therefore, the Contractor's options are either agreeing the variation or disagree and initiate arbitration. There are no other steps to resolve a variation.

Second, such unwillingness to contractually determine almost forces the Employer to reach an agreement on all changes. The Engineer evaluates and reviews the Contractor's submissions, however, acting as a mediator, with no power to agree or determine. This lack of power omits any incentive for the Contractor to compromise and negotiate with the Engineer.

Since the Employer's Representative has to pass any agreement through the Employer's internal approval process, the process ends up being the Employer's Representative coming back to the Contractor with proposals that have been accepted by the Employer's managers, until reaching one that the Contractor accepts. These two issues cause the Parties to avoid dealing with variations in due time.

When the author arrived at the project the Works were substantially complete and the Employer, Engineer and Contractor had been unsuccessfully trying to settle the variations for a few months. There were two weekly meetings which attempted for any agreement on any issue to be achieved.

The main meeting included over twelve people, Contractor's project and commercial management, Engineer and Cost control team members and Employer's Representative and commercial/claims team. The person from the Employer's side who would be required to decide/agree was not present. Therefore, the Contractor was unwilling to cooperate, since it could not 'close a deal' and any compromise it made could undergo additional negotiations. The other weekly meeting was for the Employer's internal follow up.

The number of pending open variations and claims was over sixty, and its total value was 14% of the Original Contract Amount, and the settled variations were only under 2% of the Original Contract Amount. The variations settled were agreed between Employer and Contractor more on a commercial approach, not as per best practices regarding entitlement and evaluation. The Employer would receive the Engineer's recommendation/assessment but did not allow the Engineer to inform the Contractor.

A process developed in good faith by an Employer, who simply wanted to keep control of its projects' budgets and impact on its business cases, resulted in an inadequate change management process, causing damages to both Employer and Contractor.

5.3.4. APPROACH

The author started by meeting with the Employer's top staff, the situation's assessment was that:

- At a high level, the Employer was not aware of the specific causes which did not allow for the issues to be resolved and there were sixty one issues to resolve;
- There was no prioritization regarding the issues, there were two unmatching lists of issues, one by the Engineer and the other by the Contractor;
- The Employer's Change Management process required at least five people to approve the change before it reached the final decision maker for his signature;
- At each step of approval, if a question was raised, the change would go back to the Engineer and Employer's Representative, eventually discussed with the Contractor again, most of the times restarting of the approval process;
- The Employer wanted to reach agreements as long as they were reasonable and as per the contract conditions, their intent was to agree a final account;
- The Employer did not understand that there could be issues on which the Parties would never agree, and therefore required a determination;
- The Contractor was unwilling to reach agreements and stuck to its variation proposals to which the Employer did not agree; and
- The Employer's decision maker was not involved in the actual negotiation meetings with the Contractor.

The change management process was obviously the cause why most variations were not resolved, the author identified that, the role required was one of a mediator who could regain trust of the parties. To achieve this, the author proposed the following measures regarding communication:

- Considering the importance to preserve the relationship between Employer and Contractor, the Engineer and Contractor would agree criteria regarding status of each issue;
- Based on the criteria agreed, the Engineer and the Contractor would prepare a common list of the issues, any information required and establish a tentative program to resolve each issues;
- Reporting to all of the parties would be made with that single list.

The objective was to start agreeing on something even if not on the variations, change the Contractor's perception by demonstrating that the Engineer was not simply an Employer's agent and was part of the problem solving process.

The second measure was to go back to manage the matters in line with the contract's intent. Independently of the complex Employer's approval method, there was no reason for each of the variations not to be dealt as should have been at the time of its occurrence. Meaning that after assessing their status, the process for each issue, or group of issues, would be:

- The Contractor would provide any information or data considered missing by the Engineer;

- The Engineer would review the variation and give its assessment; which in this case was only indicative, however it would give both Parties what the Engineer considered fair and reasonable and why;
- The Contractor would agree or not with the Engineer's assessment and present why;
- The Employer would assess the Engineer's and Contractor's positions and present its own position;
- The Employer and Contractor's decision makers would meet and attempt to reach an agreement;
- If an agreement could not be reached, the Employer would determine, the matter would be considered in dispute and included as such in the final account;
- Any matter not resolved within sixty days after the assessment of its status, would be closed if the Contractor had not provided information or a claim, or included in the final account disputed list considering the Engineer's recommendation.

This process had three major changes from what was happening before, first there would be no time spent in meetings to discuss status, the meetings would be only with managers to reach agreements, the rest was resolved by the technical staff and in writing. Second the Contractor would have access to the Engineer's position/recommendation, and third, since the intent was to achieve a final account and taking over, that should not be stopped in case of non-agreement on a particular issue.

5.3.5. IMPACT ON THE PROJECT

Without determinations there was no Final Account, causing contractual issues, as were not completing the taking over certificate, not triggering the start of defects liability period, not releasing bonds and not paying the Contractor for variations.

The long period without moving forward was damaging both Employer and Contractor, the Parties' frustration led to a ping-pong blame game, the Parties' had lost confidence the issues could be even resolved. Everyone saw arbitration as the only possible solution.

The actions proposed and implemented gave a way forward in cases there was no agreement, conveyed a positive feeling, the Parties could in fact agree on something and the majority of the issues was resolved.

The Parties were discussing the existence of sixty one variations; however, twenty two were not formal variations/claims, only items which the Contractor had intended to claim at a certain point.

Then there were twenty four issues under discussion between Contractor and Engineer, for which the Engineer would not issue a recommendation claiming the Contractor did not provide sufficient details, while the Contractor considered the Engineer's request was unreasonable, or was unwilling to put more effort into preparing details out of frustration, and by knowing that the Engineer had no impact on the final decision.

Changing the process into a more transparent version, allowed to either cancel variations by agreement or reach a cost agreement on fifty six out of the sixty one pending issues in nine weeks. Five issues were not agreed and/or closed, for which the Parties rejected a non-binding mediation and initiated arbitration for its settlement. In any case, the taking over and final account was achieved in fourteen weeks from the start of the implementation of the revised process.

5.3.6. LESSONS LEARNED

In the author's experience and as referred in this dissertation, a significant number of contracts have particular conditions which change in some way the Engineer's power to either instruct and/or determine variations. The author's opinion is that such adjustments cause major problems to the management of large construction contracts.

To shift the power to vary from the Engineer to the Employer may be of little consequence as long as the Employer is present, acts promptly, and the approval process is appropriate and known to all. On the other hand, the transfer of the power to determine to the Employer completely changes the intent and risk balance of the contract, and may cause one or several of the issues presented below:

- The person(s) within the Employer structure becomes unwilling to decide, because if such decision is reversed by the dispute settlement process, there may be consequences to the Employer and to that person;
- The person with authority to determine is usually an Employer's top manager, not fully knowledgeable of the project details and/or not knowledgeable to understand the issue contractually and/or technically;
- In a large organization, it is common for the approval process to require several interim review/validation stages, deeming the process to be time consuming and damage the Contractor's cash flow, as presented in section 4.4.6;
- Since the Contractor knows the Engineer has no effective power, instructions and requests to provide information may not be followed promptly;
- The Contractor may become reluctant to negotiate/agree with the Engineer anything less than what it claims; all issues need to be resolved at a very high level; and
- *Nemo iudex in causa sua*, the natural justice principle that no one should be the judge in his own case [39], which the Employer is going against.

One may understand the Employer's intent to avoid an eventually biased Engineer or that a large organization requires keeping its budget under its control, however, in the author's opinion there are far better ways to achieve such objectives without distorting the contract's risk balance.

Maintaining the Engineer's responsibility to determine is of major importance, since it allows for:

- The Engineer to have an active role regarding negotiation and settling most issues, which do not require Employer involvement;
- The Engineer being the first decision level motivating the Contractor to provide particulars and negotiate;
- Determinations to be issued and the normal contractual process to take place;
- The Employer and Contractor to keep their right to object to the determination and to raise the matter to another forum;
- The obligation for the Contractor to execute works, while the matter is under discussion;
- The principle of natural justice to be maintained, the Employer does not become the judge of his own case, which may have further consequences in case of a dispute;
- The Parties to have several appeal steps at their disposal before reaching the dispute resolution mechanism;
- The Employer to maintain all its rights regarding disputing an Engineer's determination.

Such is the intent of the FIDIC Red Book 2017, which is one of the reasons why the author believes that some of its provisions should be incorporated as soon as possible by parties of large construction contracts who develop their own ad-hoc contracts.

Further to the power to request the review of an Engineer's determination, the Employer also has the remedies under the Employer/Engineer contract to claim from the Engineer if a determination was in any way biased or negligent.

The author's opinion is that Employers of large construction projects which are taking into their hands the decision making process regarding variations, are likely to unwillingly damage themselves and others by:

- Causing project delays due to their internal change management processes;
- Causing risks to the Contractor's cash flow and therefore to the project; and
- Incurring in unnecessary costs regarding controlling a matter which they should avoid controlling.

The only eventual gain an Employer may claim is that it allows him to bully a weaker Contractor into submitting to a bad agreement for variations, however that may imply that Contractor may be of a low tier, less professional not only contractual but on all aspects, eventually delay the project, causing loss of opportunity to the Employer or other damages which the Employer does not quantify.

In summary, the author's opinion is that if/when adjusting proven standard contract conditions, in particular regarding the change management process, Employers must be transparent and such adjustments must be thoroughly discussed before implemented, consider that there will be people responsible for specific duties and actions, and that a simple adjustment may create unknown impacts.

5.4. CASE STUDY NO 04 – ASSESSMENT OF VARIATIONS

In the first half of 2018, the author was requested to support a megaproject in which the Employer's requirements were being reviewed monthly, causing contractual changes. The Contractor was very active regarding submitting claims and variations notices, for which it did not present the full appropriate contractual substantiation and/or demonstration of entitlement.

The Employer was a major property developer in the Middle East and this project included the development of general infrastructures, establishing seaside land plots for touristic and commercial developments, including major landfill, dredging and reclamation, general infrastructures, coastal protection, harbour and marina facilities.

The contract conditions did not include any time limit for substantiation of variations and/or claims, for its assessment and approval. As in the previous case study, only the Employer had the power to issue determinations for variations. The author was requested to perform the review of the Contractor variations' contractual entitlement, to attempt reducing the open issues before the matters turned into disputes.

This case study follows a different structure of the others, it presents several examples of Contractor's claimed entitlements and the author's reasoning regarding its entitlement. For each issue the author presents an introduction, the Contractor's position, the relevant contract conditions and the author's assessment and recommendation.

The issues presented are, in the author's opinion, different from more common variations and demonstrative of the knowledge and process followed while establishing contractual entitlements.

5.4.1. ISSUE NO 1 – CHANGE OF QUANTITIES OF ENVIRONMENTAL MITIGATION EQUIPMENT

It is usual in coastal developments and in most large projects, for the tender documents include an Environmental Impact Assessment (EIA) which was validated by public authorities. The Contractor budgets the necessary environmental protection measures, taking into consideration the Employer's requirements, the EIA and his own experience in similar works, and when possible in similar projects under the same authority.

In this project, the authorities approved the EIA conditioned to the future Construction Environmental Management Plan (CEMP), usually a Contractor's document in which the Contractor details how impacts on the environment and surrounding area will be avoided, minimised or mitigated [40].

After obtaining the award, the Contractor submitted its CEMP to the authorities for approval which was approved with conditions. The Contractor claimed that some of the conditions imposed by the authorities were variations.

5.4.1.1. Contractor's Variation Assessment

The Contractor argued that part of the authority's conditions to approve the CEMP were a change under the contract. The Contractor referred to the Bill of Quantities (BoQ) which defined an amount of a specific protective material, for which, according with the Contractor, the authority's approval conditions required to procure additional quantities to cover all the project.

The Employer had issued part of the authority's approved CEMP, including comments and conditions, as an instruction, deeming the Contractor to be bound to execute it. However, the instruction was for other requirements, and not the ones the Contractor claimed he was instructed to fulfil.

On the specific matter of the additional materials the Contractor was claiming, the Engineer had issued a letter requiring the Contractor to consider material re-usage between areas in line with the works programme.

Ten days after the Employer's instruction, which was not for the claimed materials, the Contractor informed the Employer it had initiated the procurement of the material required to cover all areas simultaneously, and intended to be paid as per BoQ rates for all the material, the Contractor's letter did not mention any intent to consider re-usage.

5.4.1.2. Relevant Contract Conditions

The general contract conditions defined that:

- “All instructions shall be given in writing. The Contractor shall comply with the instructions given by the Employer (and the Employer's Personnel to whom the appropriate authority has been delegated), with due expedition and without delay.”; and
- “Despite any other provision of the Contract, the Contractor shall use its Best Endeavours, and act in accordance with Best Industry Practices, to mitigate the effects of any event or circumstance which has or may adversely affect the Works, increase the Contract amount or delay the execution of the Works”.

Best endeavours is a significant obligation, which has been defined by courts as requiring a party to take all steps in their power to produce the desired results, in this case all that a reasonable Contractor could reasonably do under the circumstances [41].

Meaning that the Contractor is under the obligation to comply with the Engineer's instructions in writing to re-use the materials, and even if such instruction did not exist, the Contractor is under the obligation to do all it could reasonably do to mitigate impacts to the Contract Amount.

5.4.1.3. Author's Entitlement Assessment

The Contractor was under the obligation to comply with all authorities' requirements, even if such requirements changed after the start of the contract. However, the BoQ quantified those materials in a specific amount of meters, deeming likely that a change of quantity would be considered a variation.

The Contractor's argued that to procure all the materials required by the authorities without wasting time could be considered acting promptly and in good faith, using best endeavours to avoid any delay to the Employer.

The Engineer is likely to interpret that the Contractor is not doing the minimum effort to provide the variation detailed particulars as per the contract, and to consider that the Contractor is neglecting the Engineer's recommendation for material re-usage, which intended to mitigate cost impacts to the Contractor and Employer.

The Employer is likely to interpret that the Contractor is trying to make money out of procuring additional material making no effort to mitigate costs to the Employer, part of which may not even be necessary if the Contractor complies with the Engineer's recommendation.

The simplistic 'procure all necessary' approach by the Contractor goes against the general contract obligations to mitigate costs to Employer. The above description demonstrates how a simple event can easily become a dispute, and/or contribute to the deterioration of trust between parties.

In the author's view, the Contractor should at least substantiate his submittal taking in consideration:

- What the CEMP requirements changed the initial BoQ requirements;
- The Contractor's foreseen working method;
- The Contractor's obligations;
- Any instruction and/or communication from the Employer's Representative or the Engineer.

In fact the Contractor was:

- Requested by the Engineer to re-use the materials and had not presented any work methodology regarding rotation of material, for which Contractor had to provide a re-installation only rate;
- Advancing with procurement of materials for which it intended to be paid, without attempting to mitigate costs or giving the opportunity for the Employer to assess alternatives.

It seems each party was waiting for the other to comply with obligations, the Employer waiting for the Contractor to mitigate costs caused by the authority's conditions, the Engineer waiting for the Contractor to submit all particulars for review and approval, and the Contractor waiting for a full detailed instruction, knowing that the change process approval takes weeks/months to materialize and it will be likely financing the variation.

The author's opinion this is caused by the inadequacy of the change process: there was a likely variation caused by an authority requirement which all parties easily identified. The instruction was likely to be interpreted as a validation of the change; however, it took over ten days for the Contractor

to inform it was procuring materials for which it expected to be paid, while disregarding the obligation to mitigate costs and to take into consideration the Engineer's indication.

The issue would require several more rounds of communication to be agreed in a reasonable way. In the meantime, the project could in fact be delayed if enough materials were not procured, and the relationships were damaged because instead of cooperating as contractually intended, each party was intending for a literal interpretation of their obligations under the contract.

In the end the Contractor cancelled part of the order it had made and did a proper planning for re-usage, not before more discussions over abortive work and claims for other costs.

5.4.2. ISSUE NO 2 – AUTHORITY REQUIRES UNUSUAL SPECIFICATION

The Contractor applied to the local authorities for a permit to perform a specific work next to a public area, the authorities required special warning signs with live telemetry uploads to the authorities' information system. This was not what the Contractor had proposed to the authorities.

Unlike the above environmental measures presented in section 5.4.1 which were measured in meters, warning signs for the purpose for which the authorities had required them were a BoQ item, but the description was general and was priced as a lump sum item, there were no quantities or specifications defined anywhere else in the contract.

In this case, the Contractor claimed the authority requirement was a change because it was a particular, even unusual, specification for this type of warning sign.

5.4.2.1. Contractor's Variation Assessment

The Contractor considered that the authority request for warning signs with very particular conditions was a change of specification and therefore a variation, it argued that a reasonable Contractor would not consider that such specifications were required for this project.

The Contractor did not address the contract conditions and/or obligations.

5.4.2.2. Relevant Contract Conditions

The contract requires the Contractor to comply with Laws and execute the Works as per authorities' requirements and permits, and to "provide and maintain, at its own cost all lights, guards, fencing, warning signs, and other temporary works when and where necessary or required by the Employer's Representative or by a duly constituted Authority or any Laws, for the protection of the Works or for the safety and convenience of the public or others".

The general specifications detail the above obligation, by stating: "Provision of temporary aids to ensure safe transit at all times in accordance with the requirements of the concerned authorities".

The contract refer that "unless otherwise stated in the Contract, the Accepted Contract Amount and all unit fixed rates and prices, inserted in the Bill of Quantities, cover all the Contractor's obligations under the Contract (. . .) and all things necessary for the proper . . ., execution . . . of the Works".

The relevant Bill of Quantities lump sum item description is: "Supply and placing of temporary warning signs to ensure safe transit at all times in accordance with the requirements of the concerned authorities".

5.4.2.3. Author's Entitlement Assessment

The author's opinion is that there are facts which could deem the Contractor to be entitled or not, if there can be documentation prior to the contract signature which is demonstrative of the parties' intent regarding this matter.

An example would be if the Contractor's offer provided for any list, qualification or intention regarding what it was including related with such requirements. In this project the Contractor's offer did not provide any detail. Another situation could be if there was a preapproved plan detailing such measures, that the Employer could be or ought to be aware of, and therefore that could establish the Employer's expectation. This was not the case.

The Contractor referred to the BoQ and disregarded, that in a contract, the priority of documents clause deems the BoQ to usually be the least relevant one, meaning that what is referred on the BoQ does not usually take precedence over what is defined in the rest of the contract. This was the case in this contract.

Therefore, nowhere in the contract it was stated that any warning signs were not included in the BoQ lump sum item, or that any specification was qualified. In this case, in the author's opinion, the intention of the parties could only be that the supply of all and any authority requirements regarding such items were necessarily included in the BoQ item, placing any risk or benefit from it on the Contractor.

In order to justify this view, the author gave an example to the Contractor arguing contradiction, if the authority had accepted fewer or smaller signs than the Contractor estimated itself at tender stage, there would be no omission of part of that BoQ item, the Contractor would not propose to give a discount on the item. The item was not for a specific number or type of warning signs; it covered all and any signs, as and when required by the authorities.

In this case the cost impact between what the Contractor had proposed to the authorities and what the authorities required was not major, however what if it was? What if such requirement could damage the project by imposing an obligation on the Contractor to pay for something that it could not reasonably had foreseen and could deem the Contractor to be significantly damaged?

The intent of the parties was for such risk to be the Contractor's, it is unlikely that an aspect of reasonability could be argued. However, the author is of the opinion that, if an impact is critical for any of the parties' reasonable expectations, it is important that the parties assess it against risks and impacts on the overall project. The case in section 4.4 is an example of a one sided view leading to project failure with dramatic consequences to all parties.

5.4.3. ISSUE NO 3 – CHANGE OF WORK METHODOLOGY

Due to a change of Employer's requirements, the Engineer issued an instruction with revised drawings. This change required a different the construction method to be applied, demanding different equipment to be used in a section of the works.

5.4.3.1. Contractor's Variation Assessment

Taking into consideration the revised drawings, the Contractor presented the revised work methodology and the plus and minus list of equipment it required to perform the work.

5.4.3.2. Relevant Contract Conditions

The Contractor addressed the matter solely looking at that specific moment, and did not take into consideration how it had expressed the works to be done as per the methods and equipment included in its offer.

5.4.3.3. Author's Entitlement Assessment

In line with the Parties autonomy principle referred to in section 5.2.2.1, the basic understanding of a construction contract must be that the Contractor agreed to build what is in the drawings, as per the specifications, contract requirements and obligations, and the Employer agreed to pay the Contract Amount for that construction.

The Contractor's offer demonstrates the intent of how he considered performing the Works, unless if in conflict with the contract documents/obligations.

In the methodology presented in the offer, the Contractor proposed to perform a similar work in a similar way at a different location to what was required as per the revised drawings instruction, but with different equipment. The Contractor had also provided a list of required resources to execute all the Works.

On the particulars submitted, the Contractor had not demonstrated that this change caused it to bring to site additional equipment than it had foreseen at tender stage. In the author's opinion, the Contractor should consider:

- The equipment tender quantities foreseen;
- The actual equipment mobilization and demobilization when the work is being performed, and overall equipment throughout the project; and
- What had been caused by Employer and what was simply Contractor's choice to change its methods, or compliance with Contractor's obligation to mitigate any delay.

The Contractor was presenting a simplistic approach of what he believed he was entitled because the Employer was changing what the Contractor foresaw at the time the issue occurred, disregarding how he had proposed to do the work, for which he budgeted for and the Employer accepted to pay.

The author's position was accepted, including the fact that the Contractor had proposed to do similar work with the equipment that was claiming as additional.

5.4.4. ISSUE NO 4 – ADDITIONAL EQUIPMENT MOBILIZATION AND DEMOBILIZATION

This issue arises out of an agreed change of type of material to be used in a zone of work. Part of the work was to be executed under the construction permit existing at the time, while for the following zone, another permit was required. The work on the two zones was to be executed in sequence, by the same equipment without any stoppage time between sections.

Following the agreement to change the type of material to be used, the Contractor submitted a programme expecting the work to be performed as follows:

- Work under the existing permit was to take place between day 0 and day 26 (Zone S3);
- Work under the new permit was to take place between day 27 and day 66 (Zones S2 and S6);
- The new permit was expected to be received by day 15, however there was no issue regarding receiving it later as long as allowing for the work to start in the next zone;

- The equipment initiated its work on day 2 (2 days late);
- On day 14 the Contractor informs the Employer that, due to the fact that the new permit had not been issued yet, the Contractor was expecting to finish Zone S3 ahead of time by day 18 and he was required to commence arrangements for demobilization;
- On day 17 the Contractor receives the new permit;
- On day 20 the Contractor demobilizes the equipment.

The Contractor had only foreseen to mobilize and demobilize this specific equipment from the site once. The cost to demobilize and remobilize this industrial equipment is in excess of 3 million euros.

5.4.4.1. Contractor's Variation Assessment

The Contractor argued that it was the Employer's instruction regarding change of material that caused the need for a new permit. That the new permit was issued slightly late, the equipment was about to be out of work and the Contractor could not wait for the equipment to be stopped in order to start preparing its demobilization.

Since the equipment had to be remobilized to continue the work at a later date, the Contractor was claiming the 3 million euros remobilization and re-demobilization cost mentioned above.

5.4.4.2. Relevant Contract Conditions

On this matter the author referred to the contractual clause mentioned in section 5.4.1.2, stating that "despite any other provision of the Contract, the Contractor shall use its Best Endeavours, and act in accordance with Best Industry Practices, to mitigate the effects of any event or circumstance which has or may adversely affect the Works, increase the Contract amount or delay the execution of the Works", and to the general doctrine established by the prevention principle is that one party should not be allowed to benefit from its own default.

5.4.4.3. Author's Entitlement Assessment

There is no doubt that in this case the Employer had impacted the Contractor by instructing a change and the Contractor had been proactive in presenting a program to achieve the Employer's objectives. Further to the change of quantities for which the Contractor would be paid, if there were impacts to the Contractor because of the change, the Employer would likely be liable for.

However, the author's position was that, in this situation the Contractor could not be entitled to recover remobilization and re-demobilization costs because:

- The Contractor decided to demobilize the equipment without regard to advise the Employer, or give the Employer any opportunity to mitigate eventual costs the Contractor would intend to recover in the future;
- There was actually no requirement to demobilize the equipment since the permit arrived in time;
- Even considering the equipment work was performed faster than programmed, such is not an Employer risk; the Contractor had budgeted the cost for the equipment to be available on site at least until day 26 only for Zone S3 works;
- The equipment was owned by the Contractor and it was likely the equipment left the project to execute another work and give profits to the Contractor;
- Due to this demobilization, the Contractor actually delayed the start of Zone S2.

The facts appear to be that the Contractor demobilized the equipment at his choice/risk, without indicating to the Employer what options were available, as would be not to demobilize and have a standby cost, and/or that it intended to demobilize at Employer's cost.

Any Contractor under an obligation to mitigate costs and/or impacts, intending to take any action which may impact the Employer, must consider the prevention principle while taking actions, since that is the same principle defending the Contractor when the Employer impacts him.

5.4.5. LESSONS LEARNED

A standard contract form should define a clear path from the moment a change is identified until it is agreed, including who is responsible to do what, the process in case of no agreement and what the parties' rights are if they disagree with any decision.

The FIDIC Red Book 2017 allows the Engineer to instruct a variation or request the Contractor for the proposal [18, Sub-clause 13.3], for which the Contractor must proceed with the execution while detailing and submitting particulars. These particulars include a description of the work, details of resources and methods, a programme and any impact to the Time for completion and any adjustment to the Contract Price [18, Sub-clause 13.3.1]. This was the case of the ad-hoc contract in this project.

In this megaproject, the Contractor was in average giving notice of 1.9 changes/variations per week, half of those had either a relevant impact the in time for completion of a zone or impacts over 0.5 million euros. There was a weekly commercial meeting addressing status of each issue without putting forward each party's position, on entitlement or on a way forward.

In the author's opinion, in some cases the Contractor was 'stretching' what it claimed, however the Employer and the Engineer were not assessing the impacts of the instructions issued, and were waiting for the Contractor to identify, assess and value the impact of any changes.

A change was taking an average of 16.4 weeks to be processed, from identification to agreement regarding entitlement and impacts, and only after would be initiated the process to issue a variation order, which would later allow for the Contractor to be paid. Some changes were simple and promptly agreed, therefore the time for the Contractor to receive a formal Variation Order for significant amounts was quite long.

This is not the intent of the contract and is unlikely to be the intent of any party when entering a contract. In the author's opinion such situations happen only due to the inadequacy of change management processes. The main lessons learned are:

- In major projects, with continuous adjustments to Employer's requirements, changes occur frequently, project specific change control processes must be developed as part of managing the project's risk;
- A standard contract cannot cater for the specific circumstances of every project; it is the Employer's responsibility with whoever advises him, to establish how changes are managed;
- All parties must have appropriate staff to proactively manage changes, not to unload most of the process on the Contractor and blame it for not complying with the process.

6

CONCLUSIONS

In the previous chapters, the author presents how best practice project management guidelines, and standard contract forms, recommend that change management and change control is performed. The fact that the guidelines and the standard contract form are aligned, demonstrates that the construction industry agrees such processes are the best way to manage, control and implement variations in construction projects.

The sources presented advocate that an efficient change control is a critical success factor for construction projects, that it has been known for decades that inadequate change management is one of the leading causes of project failure, and one of the main reasons for construction contracts to end up in disputes, for Contractors to fail as businesses and for Employers' failure to achieve their objectives.

In twenty years of career, the author experienced that the construction industry continuously increases the complexity of its processes regarding management and control of variations, without addressing the root causes of why change management fails and without openly discussing such issue. On the other hand, there is a proliferation of claim and dispute management trainings, early involvement of legal and claims professionals in construction projects, causing additional costs to construction projects and its players.

In the author's experience, parties to a construction contract generally do not apply the best practices regarding change management and control, due to the fact that, the contract's particular conditions often adjust the rights and duties of the parties regarding managing variations. In the author's opinion, such adjustments to contract conditions are incorporated without any assessment and/or consideration of the shift in the contract's risk balance and its potential impacts.

The case studies and lessons learned presented are a summary of knowledge accumulated regarding management of changes in construction, presented cases from projects in which the author was directly involved as a professional. Projects in which general contract conditions were changed, impacting the parties' rights and obligations, projects in which Employers developed complex variation approval mechanisms, and where several of the decision makers lack skills and knowledge to manage changes appropriately.

From his experience and also from the time and focus on this subject while developing this dissertation, the author identified, what he believes to be, several causes of why change management processes fail. In the next page, the author summarizes in a list, factors to consider by Employers when adjusting contract conditions and developing project changes approval processes.

6.1. AVOIDING INADEQUATE CHANGE MANAGEMENT PROCESSES

Section 3.8 presents comments to relevant FIDIC Red Book 2017 clauses, namely to the Parties' duties and rights regarding management of variations. In the author's opinion, the detail in which the drafters of the FIDIC Red Book 2017 have updated and detailed the change control process is indicative of the urgency to improve what has been happening, and to mitigate the major risk in construction projects which is inappropriate change management.

Throughout his career, the author has participated and managed projects, provided support as expert on contractual issues and contractual interpretation, evaluated contract conditions while preparing offers and bids, and prepared contract particular conditions on behalf of employers.

The author has worked with, assessed risks, gave opinions and managed changes and claims on over one hundred contract conditions, and in a large majority, the rights and obligations of the Parties regarding change management were altered, either due to legal impositions or due to Employer's internal project change approval mechanisms.

Furthermore, the author has experienced that Employers' managing large portfolios of projects with complex change approval mechanisms, implement their own ad-hoc standard conditions, and continue to apply it even after previous project's failure, Contractor's collapse and/or business case failure.

While working under unaltered FIDIC Red Book conditions, the author confirmed that the variations process worked well and as intended, however those processes are often adjusted by the construction industry. On the matter of changes management, there is a clear misalignment between what Employers ought to know regarding what they should do, and what they are actually requiring Parties to do.

Having reflected on this matter, the author questioned himself on why this continues happening, why Employers don't accept best practices as defined by experts, why construction projects continue to have problems due to inadequate change management processes.

The author's conclusion is that best practices are developed by project management professionals and Engineers as guidelines, but without considering Employers' legal constraints, internal processes and/or common motivations to be the judge on their own causes.

Employers regularly adjust the risk balance and contract conditions regarding variations, and/or develop complex project changes approval processes; therefore, in the author's opinion, there should be a best practice considering such scenarios.

From the author's experience and lessons learned presented in this dissertation, while adjusting contract conditions and developing project changes approval processes, Employers should consider the following factors:

- Standard Change Management Processes should be assessed and adjusted considering each project's specific circumstances and objectives;
- The development of change approval processes should consider what are reasonable times for approvals, measures to avoid delaying the project, and measures not to constrain the Contractor's baseline cash flow;
- The change management and approval process must not cause concerns regarding job security to the persons required to act; such concern causes delays to any approval, additional/endless questions, limits ability of people to compromise, biases regarding obligations to be fair and reasonable, etc...;

- In the spirit of transparency and the principle of party autonomy, the overall change management and control process, including approval conditions, should be available and known to all parties; the Contractor ought to be aware and consider the risks of any Employer's internal change approval process;
- If changing the contractual risk balance has any gains when compared with the potential direct or indirect loss of opportunity, and/or the internal cost to process changes through a complex internal change approval mechanism;
- What resources are required to manage such processes, and what knowledge and skills such resources require to perform change control, and ensure such resources and knowledge are part of the project's requirements;
- To have the change management process commented in a bottom/up approach.

Changes may be inevitable, but disputes caused by changes aren't.

6.2. CLOSING REMARKS AND OPPORTUNITIES FOR FURTHER RESEARCH

Construction around the globe is an industry of mass employment, a positive driver for migration, a main factor of growth.

This dissertation's intent is to share experiences, considering the author's interpretation of project management best practices standards and international standard contract forms, and on issues the author has encountered during his career in international and complex contexts. It is prepared considering readers may have any level of knowledge regarding managing changes in large construction project.

The author accepts that his conclusions are based on his experience alone and may be empiric, and due to the fact that this dissertation is structured around passing experience based knowledge, the research of sources and studies on the subject was limited.

Therefore, there may be opportunities for further research to be developed, by performing in-depth research of other studies on the matter, and having the above lessons learned peer reviewed and challenged.

Also, it should be interesting to confirm, through surveys of other professionals and professional associations, if the issues and proposals identified by the author are in line with what the industry considers as most relevant, and which others should be included and addressed.

The author hopes this dissertation contributes to the knowledge in the area of management of changes and dispute avoidance in large construction projects, and that in the future, by addressing issues as the ones presented, the industry resolves the root causes for inadequate change management processes, which the author considers to be one, if not the, major reason for disputes and project failure in large construction projects.

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