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Construction Management by Civil Engineers

(On-Site Activity)

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Dedication

To my parents,

To my younger sister and brother,

To my family and friends,

To the Global Platform for Syrian Students Association.

Acknowledgement

First of all, I would like to express my gratitude to my dissertation supervisor Professor Dr João João Carlos Gonçalves Lanzinha for his patient guidance, continuous support, encouragement, and useful critiques of this research work. I deeply appreciate all the time, effort, and dedication he put into me to complete this work.

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Most importantly, I would like to express my sincere gratitude to the Global Platform for Syrian Students, its founder His Excellency Dr Jorge Sampaio (may he rest in peace), and his former diplomatic adviser, Dr Helena Barroco. Also, to the new board of directors of the platform and all the staff for the generous opportunity they have given me to study in Portugal. My educational pursuits would not be possible without their endless support, they were like a family to me during my years of study and I am greatly honoured to be part of this association.

Finally, I must express my very profound gratitude to my family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this dissertation. This accomplishment would not have been possible without them.

Resumo

A indústria da construção é vital para a economia da UE. O sector emprega directamente 18 milhões de pessoas e representa cerca de 9% do PIB da UE. Também gera novos empregos, estimula o crescimento econômico e dá soluções para preocupações sociais, ambientais e energéticas. O objetivo da Comissão Europeia é ajudar o setor a se tornar mais competitivo, eficiente em termos de recursos e sustentável. O sector da construção foi particularmente atingido pela crise financeira e económica. Este trabalho oferece uma visão geral da profissão de gestão da construção e explora as qualificações académicas e profissionais de um diretor de construção, bem como suas funções. Especificamente, o trabalho se concentra nos papéis e responsabilidades de um director de obra no planeamento, projeto, cálculo, estimativa e supervisão de projetos de construção, levando em consideração aspectos de gerenciamento de projetos e segurança, tecnologia, e exigências legais e contratuais. A pesquisa utiliza um componente de métodos qualitativos, incluindo questionários enviados com gestores de construção em prática para explorar as principais questões enfrentadas pela profissão. Os resultados desta pesquisa têm o potencial de fornecer uma compreensão mais holística das complexidades do trabalho de gestão da construção e informar as estratégias usadas para desenvolver gestores de construção mais qualificados e mais eficazes. "O conhecimento é o resultado da integração da informação através da aprendizagem". O conhecimento é definido como "o conjunto de fatos, princípios, crenças e práticas relacionadas a um determinado campo de trabalho ou estudo." Ambas as habilidades e competências são baseadas em informações factuais e teóricas; a distinção está em como esse conhecimento é implementado e colocado em uso. Como exemplo: Trabalhar como um "Diretor de Obra" requer a capacidade de combinar conceitos de engenharia com gestão de projetos e habilidades de gestão de pessoas. Esta aplicação de conhecimentos e habilidades ocorre em um ambiente um tanto imprevisível, onde dificuldades técnicas e organizacionais ocorrem regularmente e soluções devem ser desenvolvidas e implantadas instantaneamente - pelo diretor de obras sozinho ou por meio de trabalho em equipe.

Palavras-Chave:

Diretor de Obra;liderança transformacional;qualificação académica;qualificação profissional;métodos qualitativos;competências

Abstract

The construction industry is vital to the EU economy. The sector employs 18 million people directly and accounts for around 9% of the EU's GDP. It also generates new jobs, stimulates economic growth, and gives solutions to social, environmental, and energy concerns. The European Commission's goal is to help the sector become more competitive, resource-efficient, and sustainable. The construction sector has been hit particularly hard by the financial and economic crisis. This work offers an overview of the profession of construction management and explores the academic and professional qualifications of a construction manager, as well as their duties. Specifically, the work focuses on the roles and responsibilities of a construction manager in the planning, design, calculation, estimation, and supervision of construction projects, taking into account aspects of project management and safety, technology, and legal and contractual requirements. The research utilizes a component of qualitative methods, including sent-out questionnaires with practising construction managers to explore the key issues facing the profession. The findings of this research have the potential to provide a more holistic understanding of the complexities of construction management work and to inform the strategies used to develop better-qualified and more effective construction managers. “Knowledge is the result of information integration through learning”. Knowledge is defined as “the set of facts, principles, beliefs, and practises relating to a particular field of labour or study.” Both abilities and competencies are based on factual and theoretical information; the distinction is in how this knowledge is implemented and put to use. As an example: Working as a "construction manager" necessitates the ability to combine engineering concepts with project management and people management skills. This application of knowledge and abilities occurs in a somewhat unpredictable environment where technical and organisational difficulties occur on a regular basis and solutions must be developed and deployed instantly - either by the construction site manager alone or through teamwork.

Keywords

Construction manager;transformational leadership;academic qualification;professional qualification; qualitative methods;competencies

Content

Dedication ..... **iii**

Acknowledgement ..... **vii**

Resumo ..... **ix**

Abstract ..... **xi**

Content ..... **xiii**

1. General Introduction **1**

1.1 Introduction 1

1.2 Framework 2

1.3 Objective 3

1.4 Work structure 3

2. Regulatory aspects applicable to qualifications, requirements, and responsibilities related to the activity development **5**

2.1 Introduction 5

2.2 Portugal and European legislations 6

2.2.1 Portuguese codes 6

2.2.2 European Union 7

2.2.2.1 Single market 7

2.2.2.1.1 Construction Services 8

2.2.3 Europe 9

2.3 The minimum specific professional qualifications required from technicians responsible for the project's management 10

2.3.1 Civil engineer/Site director required academic qualifications 10

2.3.1.1 Academically qualified civil engineers in Europe 11

2.3.1.2 Civil engineering as a regulated profession 11

2.3.1.3 Effects of recognition 13

2.3.1.4 Activities of professional experience 14

2.3.1.5 Regulated Profession Database Tool 15

2.4 Responsibilities and guarantees from a civil perspective 23

3. Public and private construction projects 25

3.1 Principal concepts and definitions 25

3.1.1 Project management 26

3.1.2 Construction projects categories 27

3.1.3 The construction process 29

3.1.4 Public work projects 33

3.1.4.1 Instructions for the public projects work elaboration 33

3.2 Construction activity 35

3.2.1 Construction firms' obligations 35

3.2.2 Construction firms exercising its activity 35

3.2.3 Construction site manager 36

3.2.3.1 Construction site manager competencies 36

3.2.3.2 Construction site manager principal functions 36

3.2.3.3 Construction management principal areas 37

3.2.3.4 Productive resources management 37

3.3 Public contracts code (CCP) in Portugal 37

3.3.1 Public work contractors 37

3.3.2 Parties and their directorial tasks 38

3.3.3 Administrative guarantees by the contractors 38

3.3.4 Workplace order maintenance (Site Environment) 39

3.3.5 Preparation's work and accessories 39

3.3.6 Work's execution 40

3.3.6.1 Work plan 40

3.3.6.2 Payment plan 40

3.3.6.3 Execution deadline 41

3.3.7 Work suspensions 41

3.3.8 Complementary work 42

3.4 Private contracts code in Portugal 42

3.4.1 Legal Regime of Urbanization and Building (RJUE) 42

3.4.2 Construction site manager in power 44

3.4.2.1 Authorisation of use's application 44

3.4.2.2 License expiry date 45

3.4.2.3 Enforcement and work initiation 45

3.4.3 Execution of a project's works 46
3.4.3.1 Project's plan alteration while execution 46
3.4.3.2 Work conclusion and reception 46
3.4.3.2.1 Provisory and definitive reception of urban development projects 47
3.4.4 Workbook diary 47
3.4.5 Urbanistic projects sanctions and civil responsibility 48
3.4.5.1 Administrative offences 48
3.4.5.1.1 Accessory sanctions 48
3.4.5.2 Criminal responsibility 49
4. Characteristics related to leadership, organization, planning, Safety, and support instruments to the process.....51
4.1 Key Points in Safety Supervision and Management of Construction Site 51
4.1.1 The framework of health and safety in rehabilitation and maintenance of buildings with condominium management 53
4.1.2 Use of BIM tools for construction site's organisation 55
4.1.3 Construction site safety management based on Structural Equation Model (SEM) 58
4.2 Effective strategy and practice of construction site management 60
4.2.1 Site management overview 60
4.2.2 Problems in construction site management 61
4.2.2.1 Personnel issues 61
4.2.2.2 Equipment issues 62
4.2.2.3 Lacklustre of communication 63
4.2.2.4 Problems with construction materials and tools 63
4.2.3 Improvement strategy 64
4.2.3.1 Regulate on-site items finishing 64
4.2.3.2 Perfect planning 65
4.2.3.3 Strengthen quality control 65
4.3 The leadership practices of construction site managers and their influence on occupational safety 66
4.3.1 Leadership and safety performance 68
4.3.2 National culture as precursor to transformational leadership behaviour 69

4.4 Stress among site managers 72

5. Case study (sent-out questionnaire)..... 75

5.1 Introduction..... 75

5.2 Questionnaire results 77

5.3 Discussion..... 86

5.4 Conclusion 88

6. Conclusions 91

6.1 Proposals..... 93

References 95

I. Annex – A : Civil Engineering Terms' Translation [EN-PT] 103

II. Annex – B : The Civil Engineering Charter [13] 105

III. Annex – C: Construction work's classification (ordinance 701-H)[25] 107

IV. Annex – D: Questionnaire form (Case study)..... 113

List of Figures

Figure 1.1 - General overview of a construction project [unknown source].....1

Figure 2.1 - Requirments needed to become professionally registered (ICE) [20] 22

Figure 3.1 - Project management process [27]..... 27

Figure 3.2 Synthesis of the construction process. Adapted from [28]..... 29

Figure 3.3 - Project management typical activities [28] 33

Figure 4.1 - Mortal work accidents (Construction) [36] 52

Figure 4.2 - Appointment of the safety coordinator at the construction stage [39] 54

Figure 4.3 - Comparing model and live situation: Safety railing detail in the corner of the slab [47]..... 57

Figure 4.4 - Comparing model and live situation: A general view to the construction phase [47] 58

Figure 4.5 - Planning layout [43] 65

Figure 4.6 - The four elements of transformational leadership [58] 67

Figure 4.7 - Sources of Managerial Stress [85]. 72

List of Tables

Table 2.1 - Template: Structural evolution of the European Commission [2] 5
Table 2.2 Activities related to the categories of professional experience [14] 14
Table 2.3 - Construction manager regulated profession (Portugal) [16] 16
Table 2.4 - Construction manager regulated profession (Hungary) [17] 18
Table 2.5 - Civil engineer regulated profession (United Kingdom)[18].....19
Table 3.1 The Importance of the Project Phases [25]..... 34
Table 3.2 Regulated penalties values set by the municipality council [31] 48
Table 4.1 - Mortal work accidents by economic activity (Construction) [37] 53
Table 4.2 - Accident distribution according to the existence of the health and safety plan [41]..... 55
Table 4.3 - Variables and their reliability and validity tests [48]..... 59
Table 4.4 - Construction site problems [43] 64
Table 4.5 - Quantities (Q) and proportions (P) of observed leadership behaviours [79] ... 70
Table 4.6 - The 10 most frequently cited sources of stress amongst construction managers [81]..... 74
Table 5.1 - Site managers' academic and professional experience.....77
Table 5.2 - Engineers company, function and type of projects worked on 78
Table 5.3 - Country and knowledge of the engineers 79
Table 5.4 - Programmes and their use by the construction managers..... 79
Table 5.5 - Regulations and codes 80
Table 5.6 - Engineers understanding of the construction management profession 82
Table 5.7 - Charachter/personality of a construction manager 83
Table 5.8 - Challenges and problems on-site 83
Table 5.9 - How to deal with stress and pressure as a construction manager 84
Table 5.10 - Construction management more recognised and efficient 86

List of Acronyms

ECCE	European Council of Civil Engineers
ICE	Institution of Civil Engineers (UK)
CMAA	Construction Management Association of America (USA)
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardization
GDP	Gross Domestic product
EEC	European Economic Community
CCP	Public Contracts Code (Código dos Contratos Públicos-PT)
IMPIC, I. P.	Public Market Institution of Real estate and Construction (Instituto dos Mercados Públicos do Imobiliario e da Construção-PT)
CIOB	Chartered Institution of Building (UK)
JBM	Joint Board of Moderators (UK)
IPD	Initial Professional Development (UK)
RJUE	Legal Regime of Urbanization and Building (Regime Jurídico da Urbanização e Edificação-PT)
SEM	Structural Equation Modelling
CM	Construction Manager
OE	Engineers Order (Ordem dos Engenheiros-PT)
OET	Technical Engineers Order (Ordem dos Engenheiros Técnicos-PT)
ANQEP	National Agency for Professional Qualification and Education (Agência Nacional para a Qualificação e Ensino Profissional-PT)
AO	Order of Architects (Ordem dos Arquitetos-PT)
AAES	Higher Education Assessment Agency (Agência de Avaliação do Ensino Superior-PT)
CMAA	Club Management Association of America
PMISs	Project Management Information Systems

1. General Introduction

1.1 Introduction

The history of construction management dates back to various periods. It has undergone significant changes in its practices and attitude. Despite the positive feedback that it has received from its users, the entry of construction management into the building industry has sparked debate among those who are concerned about its market share. The evolution of construction management has been marked by significant advances in understanding its various aspects. Despite its numerous achievements, construction management has been criticized due to its unusual characteristics.

The construction industry is fundamental in ensuring that the ambitions of the Recovery Plan and the Green Deal embrace the opportunity for a stronger and more sustainable Europe moving forward. With the ongoing changes projected in Europe over the past several decades and into the current one, a new approach to leadership development is required. The construction sector is a highly complicated industry with several challenges and issues.

Construction Management (CM) is an exception in the industry's long history. As a result, it has been dogged by controversy. Now that its brief but dynamic evolution has reached an interpretative degree of maturity, useful discussion of CM's characteristics is conceivable when previously only debate would have prevailed.

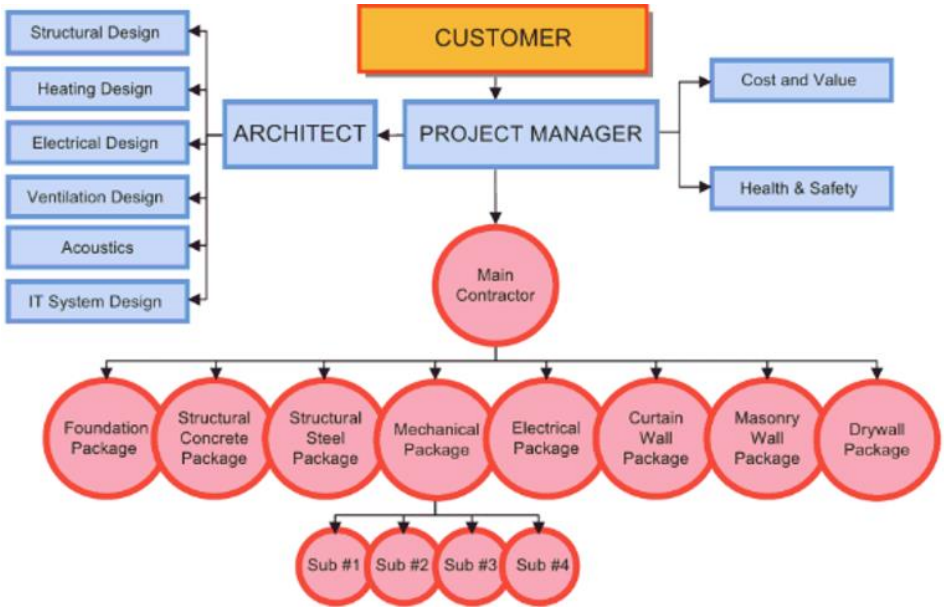

Figure 1.1 - General overview of a construction project [unknown source]

1.2 Framework

Construction managers have traditionally joined the process later than other managers, usually after bidding. However, this has changed in recent years. Construction managers are now getting involved early in the design process and delivering substantial value. Sophisticated owners are specifically encouraging construction managers to arrive at the table early, realising the long-term benefits. This allows the construction manager to help identify cost efficiency strategies, constructability concerns and cost avoidance strategies when making decisions in the design. Additionally, the construction manager is usually able to provide construction schedule analysis and offer input for better long-term asset management.

In Portugal, the Public Contracts Code (CCP) governs construction work procured by the government. In general, the parties cannot change or exclude the requirements of this code. Contracts for the design and construction of works procured by a private sector developer provide for greater flexibility in negotiating their own terms and conditions. The public sector is required to utilise a standard type of contract that complies with the provisions of the Public Contracts Code while doing public works. In the case of private works, the parties must employ a standard form contract that complies with the norms of the Civil Code and, in some cases, the Public Contracts Code e.g. (price, additional works, etc). The two most important parties are the employer and the contractor. The contractor may be in charge of both construction and engineering services (directly or through a subcontractor), or only construction. If the employer contracts for construction and engineering services, the contractor will be solely responsible to the employer. If, on the other hand, the engineering services are hired directly by the employer, the contractor will have no contractual relationship with the engineering firm and so will not be held accountable for providing such services. The construction must be completed in compliance with the specifications provided by the employer.

Construction management is a professional service that provides successful management of a project's time, cost, quality, safety, scope, and function to the project's owner(s). All project delivery methods are compatible with construction management. A Construction Manager's (CM) responsibility is to the owner and to the success of the project, regardless of the location. The CM represents the owner's interests and directly supervises the entire project for the owner. His/her mandate is to collaborate with all partners to complete the project on schedule, on budget, and to the owner's expected quality, scope, and function. Through their combined education and experience, CMs are uniquely qualified to

collaborate with the owner, architect, general contractor, and other stakeholders to determine the best possible sequence of construction operations and develop a detailed schedule and budget, while also establishing plans for project safety and security and assisting the owner in risk management. This necessitates the use of Project Management Information Systems (PMISs) and complicated planning approaches such as critical path methodologies, as well as construction method understanding. A 2013 study [1] sponsored by the CMAA Foundation and McGraw-Hill Construction found that utilising experienced CMs saved money, prevented, or minimised difficulties, and generated higher-quality solutions for owners. Professional project managers employ industry-standard procedures to successfully manage projects. The CM Body of Knowledge and Standards of Practice addresses all six areas of construction management services: schedule, cost, safety, quality, function, and scope.

1.3 Objective

The general objective of this dissertation consists of reviewing knowledge about the main activities of the director of public and private works. Analyse the legal and regulatory aspects applicable to qualifications, requirements and responsibilities related to the development of the activity. Study characteristics related to leadership, organization, planning and instruments to support the performance of the function. Analyse case studies. Draw conclusions with the aim of proposing a support script.

1.4 Work structure

This work is entitled “Construction Management by Civil Engineers - On-Site Activity”, and it is divided into 6 chapters.

The first chapter presents a brief history segment about the profession of construction management its activities, and challenges. Demonstrating the theoretical framework of the study and defining the concept of the construction manager and his duties.

The second chapter is more about the regulatory aspects to the qualifications and requirements in Europe and particularly in Portugal related to the construction management as a profession and to construction manager as qualified professionals.

The third chapter goes deeper into the legal regime and public contracts code in Portugal in terms of construction projects on a national level. Explains the construction activities from construction companies and construction manager point of view, a brief delivery of the sanctions and disqualifications a construction manager could face.

The fourth chapter raises the issues of construction sites safety, organisation, software used by construction managers. The effective strategies and practices. The essential characteristics of a construction manager, and how stress could affect the success of the project.

The fifth chapter fundamentally is a small qualitative analyse to a sample of few construction managers who are in the past, or currently exercising the profession. Results shown after collecting data from pre-made questionnaire. Discussion of results and conclusions with small proposal for some key point issues.

In the sixth chapter conclusions of the work are presented, giving some personal learnings outcome as futuristic proposals.

2. Regulatory aspects applicable to qualifications, requirements, and responsibilities related to the activity development

2.1 Introduction

Construction regulations and safety legislation were created to ensure that the project we tend to construct is structurally-sound, safe, and meets the sanitation requirements for healthy living. Also, a basic environmental standards requirement must be checked.

Construction law is a branch of law dealing with matters related to architecture, engineering, and related fields. It is essentially a mixture of contract, commercial, planning, labour, and tort laws. The construction act covers a wide range of legal issues, including contracts, negligence, guarantees, bonds and bonding, liens and other collateral rights, bids, building claims, and related consultant contracts. Construction laws affect many stakeholders in the construction industry, including financial institutions, surveyors, architects, engineers, builders, planners, and more.

Table 2.1 - Template: Structural evolution of the European Commission [2]

<table>
<tr><td>Signed</td><td>1951</td><td>1957</td><td>1965</td><td>2007</td></tr>
<tr><td>In force</td><td>1952</td><td>1958</td><td>1967</td><td>2009</td></tr>
<tr><td>Document</td><td>Paris Treaty</td><td>Rome Treaties</td><td>Merger Treaty</td><td>Lisbon Treaty</td></tr>
<tr><td rowspan="3"></td><td></td><td>Commission of the European Atomic Energy Community</td><td rowspan="3">Commission of the European Communities</td><td rowspan="3">European Commission</td></tr>
<tr><td colspan="2">High Authority of the European Coal and Steel Community</td></tr>
<tr><td></td><td>Commission of the European Economic Community</td></tr>
</table>

A new executive institution was established on January 16th, 1958, called the European commission (See Table 2.1), it operates as a cabinet government, with 27 members of the Commission (informally known as "Commissioners") headed by a President. It includes an administrative body of about 32,000 European civil servants. The Commission is divided into departments known as Directorates-General (DGs) that can be likened to departments

or ministries each headed by a Director-General who is responsible to a commissioner. Responsible to: European Parliament; European Council [3].

2.2 Portugal and European legislations

2.2.1 Portuguese codes

The main sources of law that govern and regulate contracts for designing or carrying out building works in Portugal are, the execution of public works is governed by Decree-Law No. 18/2008, of 29 January 2008, which enacted the Public Contracts Code ('Public Contracts Code') as amended by Decree-Law No. 149/2012, of 12 July 2012, Decree-Law No. 214-G/2015, of 2 October 2015, Decree-Law No. 111-B/2017, of 31 August 2017, Decree-Law No. 33/2018, of 15 May 2018, Decree-Law No. 170/2019, of 4 December 2019 and Parliament Resolution No. 16/2020, of 19 March 2020. Construction works that are procured by private (non-public sector) entities are governed by the Civil Code, enacted by Decree-Law No. 47344, of 25 November 1966 ('Civil Code') [4].

Furthermore, the construction of a building itself must be authorized by the municipality before the contractor can start the work. The construction permit is usually applied for by the employer and issued by Decree-Law No. 555/99, of 16 December 1999, as amended by Decree-Law No 26/2010, of 30 March 2010 – The Legal Framework for Urbanization and Building, Decree-Law No. 214-G/2015, of 2 October 2015, Law 79/2017, of 18 August 2017, Decree-Law No. 121/2018, of 28 December 2018, Decree-Law No. 66/2019, of 21 May 2019 and Law No. 118/2019, of 17 September 2019 [4].

For health and safety matters there are main rules on construction sites, the main statutes that govern health & safety matters on construction sites are:

- Decree No. 41821/58, of 11 August 1958, which brought into effect the General Regulations on Safety at Construction Sites.
- Decree No. 46427/65, of 10 July 1965, which brought the Regulations on Temporary Premises for Construction Workers into effect.
- Ministerial Order No. 101/96, of 4 March 1996 – Minimum Safety and Health Requirements Applicable to Construction Sites.

Decree-Law No. 273/2003, of 29 October 2003, which revised health and safety regulations on temporary and mobile construction sites, to take into account the minimum health and

safety requirements required by European Council Directive 92/57/EEC. These statutes only apply to the construction of buildings, and not to their subsequent use or operation.

The health and safety requirements that concern the use of a building may vary depending on its purpose commercial, industrial or services [4].

2.2.2 European Union

The Commission helps to shape the EU's overall strategy, proposes new EU laws and policies, monitors their implementation, and manages the EU budget. It also plays a significant role in supporting international development and delivering aid. For example:

- In strategy and policy
- In budget and funding
- In international relations
- In law : In certain areas, both the EU and member countries are able to pass laws. But member countries can do so only if the EU has not already proposed laws or has decided that it will not. In these areas, the EU has what the treaties call shared competences. For example :

  Single_market, employment and social affairs, economic, social, and territorial cohesion; agriculture, fisheries, environment, consumer protection, transport, trans-European networks, energy, justice, and fundamental rights, migration and home affairs, public health (for the aspects defined in Article 168 of the Treaty on the Functioning of the European Union), research and space, development cooperation and humanitarian aid.

2.2.2.1 Single market

In the EU's single market (sometimes called the internal market) people, goods, services, and money can move around freely. Mutual recognition guarantees that any product lawfully sold in one EU country can be sold in all others. EU citizens can study, live, shop, work and retire in any EU country - and enjoy products from all over Europe [5].

It was subdivided and classified for various policies depending on the needs of the EU citizens:

1. Single market for goods;
2. Capital markets union;

3. Tackling barriers to trade;
4. Public procurement;
5. European market for space data;
6. European standards;
7. Single market for services.

- Single market for services : This division aim to remove the barriers for companies looking to offer cross-border services, whence the services are crucial to the EU economy. They account for around 70% of the EU's Gross domestic product - GDP and an equal share of its employment [6].

2.2.2.1.1 Construction Services

Construction services are key to the EU economy. Construction works undertaken by builders and developers account for 6.1% of EU GDP and 7.3% of EU employment. Based on its high economic importance and low single market integration, the European Commission has identified construction as a priority services sector for internal market policy action.

The construction sector was particularly impacted by the economic crisis and its recovery is proving slow in the face of relatively low average productivity and persistent legal barriers. Restrictive national regulation results in little cross-border activity. There is significant untapped growth potential for construction services in the EU today if construction service providers are allowed to make full use of a true single market [7].

The EU legislations related to the construction industry: the 2006 Services Directive introduced rules and principles to allow services providers across many sectors. In 2011, the Construction Product Regulation, laid down harmonised rules for the marketing of construction products in the EU. For public works, construction service provider activities are also the object of specific EU Procurement Law.

Beyond internal market legislation applicable to professional services in the field of construction (architects, engineers, and craftsmen), the performance of construction services is directly impacted by specific fields of law, including environmental, energy

efficiency, urban and spatial planning, labour, and social security law, with some of this legislation introduced at EU level [7].

In the pursuit of the goal of making business easier between European countries, one of the single market services called Free movement of professionals where professionals in the EU can move across borders and practice their occupation or provide services abroad. These webpages provide practical information on EU legislation governing the recognition of professional experience in the EU [8].

2.2.3 Europe

The European Committee for Standardisation (CEN) brings together the national standardization bodies of 33 European countries. It provides a platform for the development of European standards and other technical documents on various types of products, materials, services, and processes. These include air and space, chemicals, construction and more [9].

“European standard” means a standard adopted by a European standardisation organisation and made available to the public [10].

The construction sector is one of Europe's biggest industries, representing about 9% of the EU's GDP and 50.5% of Gross fixed Capital formation. It employs more than 18 million EU citizens, and it is estimated that 26 million workers in the European Union depend, in one way or another, on the construction sector.

CEN and CENELEC, as two of the official European Standardization Organizations (ESOs), support the construction sector, developing harmonized European standards in support of the Construction Products Regulation (Regulation EU 305/2011 - CPR). European product standards, the core of the harmonized standards, are an essential tool for all stakeholders in the construction sector. They enhance the internal market allowing the free movement of construction products in the European Union and increase the competitiveness within this industry.

The construction sector is fundamental in ensuring that the ambitions of the Recovery Plan and the Green Deal embrace the opportunity for a stronger and more sustainable Europe

moving forward: take for example the Renovation Wave, issued in the past few months by the European Commission which calls specifically for climate resilient building standards.

Given the importance and broad applicability of the construction sector, stakeholders working on standards in the field include manufacturers of construction products, national and European industry associations, laboratories and notified bodies, engineers, structural designers, the scientific community, and the European Commission [11].

2.3 The minimum specific professional qualifications required from technicians responsible for the project's management

The European Commission created a general system for the recognition of professional qualifications in practice. The system of recognition of professional qualifications in the EU is governed by Directive 2005/36/EC, recently amended by Directive 2013/55/EU. The directive provides a modern EU system of recognition of professional experience and promotes automatic recognition of professional experience across the EU.

In May 2020 the Commission published a report on the implementation of certain new elements introduced by Directive 2013/55/EU and an accompanying staff working document [8].

The recognition of professional qualifications set by Directive 2005/36/EC allows professionals such as doctors, civil engineers, and architects to move freely within the EU. Some professions, such as sailors and air aircraft controllers, are exempt from the Directive 2005/36/EC's recognition processes and are controlled by a separate law. Lawyers have their own set of rules [12].

2.3.1 Civil engineer/Site director required academic qualifications

Over the past several decades, the civil engineering profession in Europe has faced massive and rapid changes, expanding the knowledge needed of the profession to cover new areas such as environment, sustainable management, health, safety, energy, planning, operation, and so on.

These changes have created an atmosphere in which professional civil engineers are required to have a broader understanding as well as more specialised technical competence than previous generations.

These changes have generated discussions regarding the sufficiency of civil engineering education and if courses should be enhanced. As a result of the Lisbon declaration and other global initiatives, many countries have increased the length of academic study required of professional qualified civil engineers.

2.3.1.1 Academically qualified civil engineers in Europe

Different countries have invariably taken different approaches to determining the educational requirements for civil engineers. As a result, academic degrees differ in content and duration from one country to another.

Southern and Eastern European countries favour a comprehensive academic formation, resulting in a longer than average term of academic education. Whereas countries in Central and Northern Europe have tended to adopt more specialised degrees as well as shorter-term diplomas. Several countries provide both broad and specialised diplomas.

This difference in academic content has resulted in varying national expectations of civil engineers working throughout Europe. This difference can be seen when evaluating the many engineering acts performed by civil engineers across Europe in infrastructure planning, design, construction, operation, maintenance, and decommissioning/demolition. The European Council of Civil Engineers - ECCE civil engineering charter exemplifies this, can be found in the annex - B [13].

The adopted communication from the European Commission entitled “New European Labour Markets, Open to all, with access to all” following the meeting of the council held in Lisbon on 23 and 24 of March 2000.

2.3.1.2 Civil engineering as a regulated profession

The European Parliament and the European Council (EC) announced in 2005 a directive that establishes rules to wish a Member State which makes access to or pursuit of a regulated profession in its territory upon possession of specific professional qualifications obtained in

one or more other Member State which allow the holder to pursue the same profession there, also concerning partial access to of professional traineeships pursued in another Member State [14].

Each Member State may permit Member State nationals in possession of evidence of professional qualifications not obtained in a Member State to pursue a regulated profession within the meaning the definition on its territory in accordance with its rules.

For the purpose of this work, the following definitions apply [14]:

a) "Regulated profession": a professional activity or group of professional activities, access to which, the pursuit of which, or one of the modes of pursuit of which is subject, directly or indirectly, by virtue of legislative, regulatory or administrative provisions to the possession of specific professional qualifications; in particular, the use of a professional title limited by legislative, regulatory or administrative provisions to holders of a given professional qualification shall constitute a mode of pursuit and be treated as a regulated profession;

b) "Professional qualifications": qualifications attested by evidence of formal qualifications, an attestation of competence and/or professional experience;

c) "Evidence of formal qualifications": diplomas, certificates and other evidence issued by an authority in a Member State designated pursuant to legislative, regulatory, or administrative provisions of that Member State and certifying successful completion of professional training obtained mainly in the Community. Where the first sentence of this definition does not apply, evidence of formal qualifications shall be treated as evidence of formal qualifications;

d) "Regulated education and training": any training which is specifically geared to the pursuit of a given profession and which comprises a course or courses complemented, where appropriate, by professional training, or probationary or professional practice.

e) "Professional experience": the actual and lawful full-time or equivalent part-time pursuit of the profession concerned in a Member State;

f) "European Professional Card": an electronic certificate proving either that the professional has met all the necessary conditions to provide services in a host Member State on a temporary and occasional basis or the recognition of professional qualifications for establishment in a host Member State;

g) "Competent authority": any authority or organisation specifically empowered by a Member State to issue or receive training diplomas and other certificates or

information, as well as to receive applications and make the choices specified in this Directive.

The structure and degree of professional training, probationary or professional practice shall be regulated by the relevant Member State's laws, regulations, or administrative provisions, or shall be supervised or approved by the authority appointed for that purpose.

2.3.1.3 Effects of recognition

1. The host Member State's recognition of professional credentials entitles beneficiaries to work in the same profession for which they are qualified in their home Member State and to pursue it in the host Member State under the same conditions as its nationals.
2. For the purposes of this Directive, the profession that the candidate desires to follow in the host Member State is the same as that for which he is qualified in his home Member State if the activities covered are equivalent.
3. Partial access to a profession in the host Member State shall be granted under the conditions laid down:
    a) The professional is fully qualified to exercise in the home Member State the professional activity;
    b) The differences between the legally exercised professional activity in the home Member State and the regulated profession in the host Member State as a whole are so great that applying compensation measures would entail requiring the applicant to complete the entire programme of education and training required in the host Member State in order to have access to the full regulated profession in the host Member State;
    c) The professional activity can objectively be separated from other activities falling under the regulated profession in the host Member State.

To ensure the efficacy of the system for the recognition of professional qualifications, uniform formalities, and rules of process, as well as certain details of the profession's pursuit, should be determined.

2.3.1.4 Activities of professional experience

There are major groups of activities related to the categories of professional experience covered by Directive 64/427/EEC, explaining the requirements to access or pursuit one of the regulated professions so it can be recognized by the Member States showing professional knowledge and aptitudes sufficient as a proof. In accordance with article 17, list I as in the table below:

Table 2.2 Activities related to the categories of professional experience [14]

Major group	**40**	**Construction**
	400	Construction (non-specialised); demolition
	401	Construction of building (dwelling or other)
	402	Civil engineering; building of roads, bridges,
	403	Installation work
	404	Decoration and finishing

The activity in question must have been pursued:

a) for six consecutive years on a self-employed basis or as a manager of an undertaking; or

b) for three consecutive years on a self-employed basis or as a manager of an undertaking, where the beneficiary proves that he has received previous training of at least three years for the activity in question, evidenced by a certificate recognised by the Member State or judged by a competent professional body to be fully valid; or

c) for four consecutive years on a self-employed basis or as a manager of an undertaking, where the beneficiary can prove that he has received, for the activity in question, previous training of at least two years' duration, attested by a certificate recognised by the Member State or judged by a competent professional body to be fully valid; or

d) for three consecutive years on a self-employed basis, if the beneficiary can prove that he has pursued the activity in question on an employed basis for at least five years; or

e) for five consecutive years in an executive position, of which at least three years involved technical duties and responsibility for at least one department of the company, if the beneficiary can prove that he has received, for the activity in

question, previous training of at least three years' duration, as attested by a certificate recognised by the Member State or judged by a competent professional body to be fully valid.

2.3.1.5 Regulated Profession Database Tool

As a general rule, a profession is regulated if the person have to hold a specific degree to access the profession, do special exams such as state exams and/or register with a professional body before he/she can practise it. If the profession is regulated in the EU country where he/she wants to practise, he/she may still need to apply to get their professional qualification recognised there.

The Regulated Professions Database contains information on regulated professions, statistics on migrating professionals, contact points and competent authorities, as provided by EU Member States, EEA countries, the UK and Switzerland.

In order to properly use the database system is to search for the required qualification in which country was awarded, and to search for the profession in the native language on which the origin of the qualification. If a person couldn't fine information about a specific profession, there are a national contact points for professional qualification related to each member state [15].

For the first provision of services, in the case of regulated professions that have public health or safety implications which do not benefit from automatic recognition, the competent authority of the host Member State may check the professional qualifications of the service provider prior to the first provision of services. Such a prior check shall be possible only where the purpose of the check is to avoid serious damage to the health or safety of the service recipient due to a lack of professional qualification of the service provider and where the check does not go beyond what is necessary for that purpose.

No later than one month after receipt of the declaration and accompanying documents as proof of the nationality, an attestation certifying that the holder is legally established in a Member State, evidence of professional qualifications, the competent authority shall inform the service provider of its decision - art 7.4 [14] :

1. Not to check his professional qualifications;
2. Having checked his professional qualifications.

i. To require the service provider to take an aptitude test; or

ii. To allow the provision of services.

Taking Portugal, Hungary, and United Kingdom as examples for the purpose of the work, after the search of the profession site manager/work director, the results for these specific countries were organised and put in Tables 2.3, 2.4, 2.5:

Table 2.3 - Construction manager regulated profession (Portugal) [16]

General Information	
Generic Name of Profession	
Identification	
REGULATED PROFESSION NAME	Diretor de obra
Translation(s):	Construction Manager (EN)
Country:	Portugal
Region:	All Regions
Legal Information	
Legal Basis for Regulation	
EU Law:	None
National Legislation:	Law No 31/2009 modified by Law No 40/2015
Useful Link:	dre.pt/pdf1s/2009/07/12700/0427604285.pdf
Regulation	
Type of Regulation:	Reserves of activities
Recognition	
Recognition Under:	DIRECTIVE 2005/36/EC
Additional Information:	Besides qualified professionals with attestation of competence or vocational training also can pursue this activity the technicians holding a diploma of post-secondary level(3-4 years) in engeneering, architecture, and other in the construction area.
Recognition Under Directive 2005/36/EC:	General system of recognition - primary application
Qualification Level:	ATT - Attestation of competence , Art. 11 a
Prior Check of Qualifications Under Article 7(4):	Yes
Justification for Article 7(4):	The prior check of qualification is needed to the protection of people and goods as well as consumer protection.
Activities	
Definition:	The construction manager is the qualified professional who makes sure that the works are executed according to the project, when applicable, that conditions regarding the licence or the prior notification are met, and that the applicable laws and regulations are complied with. Their work involves: ensuring the technical supervision of the works and the coordination of the whole production activity, in case their employer company is responsible for the execution of the construction works; adopting the appropriate production methods, to ensure compliance with their legal obligations as well as work quality and safety and efficiency within the construction process; ensuring that the project is correctly implemented, by

	coordinating, supervising and carrying out the works according to the project and complying with the requirements for obtaining a licence or entering in the construction industry, in the context of an administrative or public contractual procedure.

Competent Authorities

Competent authorities are responsible to take a decision when a professional from another member state wants to practise this regulated profession. In case of provision of service, the declaration must be sent to this authority prior to the provisioning of services.

Name	Address	Contact
Instituto dos Mercados Públicos, do Imobiliário e da Construção, I.P.(IMPIC) Institute for Public Procurement, Real Estate and Construction, I.P. (IMPIC) (EN)	Av. Júlio Dinis, 11 1069-010 Lisboa	Phone : +351 217 946 700 Fax : +351 217 946 799 Email : geral@impic.pt URL : www.impic.pt/impic/pt-pt/

Reserved Activities	Project management including construction cost management, monitoring of construction/ execution of the project	
	Shared Activity:	Yes
	Professions with whom activity is shared:	
	Engineers, Architecs,Thecnical Engineers and others with lower profissional qualification	
Qualifications		
Qualification 1		
Method to obtain qualifications:	General post-secondary education	
Duration of education/training programme:	Other Engineer-5 years+6 months (also 3 years+18 months)	
Qualification 2		
Method to obtain qualifications:	General post-secondary education	
Duration of education/training programme:	Other Technical Engineer-3 years	
Qualification 3		
Method to obtain qualifications:	General post-secondary education	
Duration of education/training programme:	Other Architect-5 years+12 months	
Qualification 4		
Method to obtain qualifications:	Vocational post-secondary education level	
Duration of education/training programme:	Other Professionals according the Catálogo Nacional de Qualificações and others preview in Law nº 40/2015	
Qualification 5		
Method to obtain qualifications:	Professionals with several years of profissional experience,without secondary education level	
Most common path to obtain qualification:	Proof case by case	
Duration of education/training programme:	Other Case by case	

The Portuguese authority consider that the Law Nº 40/2015, of June 1, establishes requirements to an appropriate access to this profession, being that this authority proceed a required surveillance compliance, ensuring an effective professional regulation. And the professionals who can carry this profession are engineers, technical engineers, architect or other professionals, whose practice of professional acts is regulated by OE - Ordem dos Engenheiros, OET - Ordem dos Engenheiros Técnicos, OA - Ordem dos Arquitetos e AAES-

Agência de Avaliação do Ensino Superior, as well ANQEP - Agência Nacional para a Qualificação e Ensino Profissional and other entities.

Table 2.4 - Construction manager regulated profession (Hungary) [17]

General Information	
Generic Name of Profession	
Identification	
REGULATED PROFESSION NAME	építőmérnök
Translation(s):	civil engineer (EN)
Country:	Hungary
Region:	All Regions
Legal Information	
Legal Basis for Regulation	
EU Law:	None
National Legislation:	1997. évi LXXVIII. törvény, 1996. évi LVIII. törvény, 266/2013. (VII. 11.) Kormány rendelet
Useful Link:	njt.hu/cgi_bin/njt_doc.cgi?docid=161886.245196
Regulation	
Type of Regulation:	Reserves of activities
Recognition	
Recognition Under:	DIRECTIVE 2005/36/EC
Additional Information:	None
Recognition Under Directive 2005/36/EC:	General system of recognition - primary application
Qualification Level:	PSM - Diploma from post-secondary level (more than 4 years) , Art. 11 e
Prior Check of Qualifications Under Article 7(4):	No
Prior check of qualifications only for individual professionals not benefiting from automatic recognition:	No
Activities	
Description of Activities (EN):	Technical planning of buildings, technical control of construction, responsible technical management. Regulations are applicable to every engineer working in construction by professional competency: civil engineers, electrical engineers, mechanical engineers, energy engineers, if they undertake activities that qualify as architectural, technical design in accordance with Sections 32 and 33 of the Building Act.

Competent Authorities

Competent authorities are responsible to take a decision when a professional from another member state wants to practise this regulated profession. In case of provision of service, the declaration must be sent to this authority prior to the provisioning of services.

Name	Address	Contact
Budapesti és Pest Megyei Mérnöki Kamara - Budapest and Pest County Chamber of Engineers (EN)	Angyal utca 1-3. 1094 Budapest	Phone : +36 1 455-70-80
		Fax : +36 1 455-70-89
		Email : info@mmk.hu
		URL : www.bpmk.hu

Reserved Activities	Design and planning, feasibility studies, Ensuring compliance of related documentation or certification of project/ Signing of designs and technical control / Representation for obtaining permits, Planning and management maintenance; survey of sites, Project management including construction cost management, monitoring of construction/ execution of the project and Others
	Shared Activity : Yes
	Professions with whom activity is shared:
	1- Architectural-technical design activity in accordance with Part 2, Chapter I, Annex 1 of Government Decree 266/2013. (VII.11.)
	2- Construction-technical inspector and responsible technical supervisor activities in accordance with Chapter III and Chapter IV, Annex 1 of Government Decree 266/2013. (VII.11.)
	3- Architectural-technical design activity in accordance with Part 2, Chapter I, Annex 1 of Government Decree 266/2013. (VII.11.)
	4- Construction-technical inspector and responsible technical supervisor activities in accordance with Chapter III and Chapter IV, Annex 1 of Government Decree 266/2013. (VII.11.)
	5- Full-scope design, control and management of the construction of general and special buildings.
Qualifications	
Qualification 1	
Method to obtain qualifications:	General post-secondary education
Duration of education/training programme:	5.5 Year
Existence of mandatory traineeship:	Yes (6 months)
Restrictions	
Mandatory registration in professional bodies:	Yes

Table 2.5 - Civil engineer regulated profession (United Kingdom)[18]

General Information	
Generic Name of Profession	
Identification	
REGULATED PROFESSION NAME	Member of ICE (MICE), Chartered Civil Engineer
Title:	civil engineer
Country:	United Kingdom
Region:	All Regions
Legal Information	
Legal Basis for Regulation	
EU Law:	Other (Royal Charter of 11 June 1975)
National Legislation:	Royal Charter of 11 June 1975
Useful Link:	www.ice.org.uk/Information-resources/Document-Library/ICE-Royal-Charter,-By-laws,-Regulations-and-Rules
Regulation	

Type of Regulation:	Protected title (without reserves of activities)
Recognition	
Recognition Under:	DIRECTIVE 2005/36/EC
Additional Information:	None
Recognition Under Directive 2005/36/EC:	General system of recognition - primary application
Qualification Level:	PS4 - Diploma of post-secondary level (exactly 4 years) , Art. 11 e
Prior Check of Qualifications Under Article 7(4):	No
Activities	
Description of Activities (EN):	Chartered Civil Engineers develop solutions to engineering problems using new or existing technologies, through innovation, creativity and change and/or they may have technical accountability for complex systems with significant levels of risk.

Competent Authorities

Competent authorities are responsible to take a decision when a professional from another member state wants to practise this regulated profession. In case of provision of service, the declaration must be sent to this authority prior to the provisioning of services.

Name	Address	Contact
Institution of Civil Engineers - ICE	One Great George Street, Westminster SW1P 3AA London	Phone : +44 (0)20 7665 2174
		Fax : N/A
		Email : erp@ice.org.uk
		URL : www.ice.org.uk

Reserved Activities	Reservoir Panel Engineer (under Reservoirs Act 1975). Approved Certifier of Design (Building Structures)
Qualifications	
Qualification 1	
Method to obtain qualifications:	Demonstration of competence as defined in ICE Member Attributes, assessed by Professional Review (peer interview), following a prior assessment of formal or informal learning outcomes and professional development (training and experience) to the required level. Duration of education/training programme is an indicative time.
Duration of education/training programme:	8 Year
Existence of mandatory traineeship:	No

The 8 years duration of education and training programme in the UK example, apparently is divided between academic, professional progression and depends on the graduated student if is professionally accepted by the CIOB - Chartered Institution of Building.

To become a construction manager and get the title through:

- A university course;
- An apprenticeship;
- Working towards the role;
- Applying directly.

University: a foundation degree needed, higher national diploma or degree in subject like:

- Building studies or building engineering;
- Surveying or civil engineering;
- Construction engineering;
- Construction site management;
- Estimating.

Apprenticeship: doing a degree apprenticeship in:

- Construction site management;
- Design and construction management.

These typically take between 3 and 4 years to complete, as a mix of learning in the workplace and studying at an approved university.

Work: A graduated civil engineering student may be able to move up into this role after gaining several years' experience in another construction industry role like:

- Estimator
- Building technician
- Surveyor
- Site supervisor

Direct Application: After getting several years' management experience in related industry role like civil engineering a person could apply directly.

In order to become professionally qualified and recognized, there are three stages based on:

- Academic qualifications;
- Work experience (also called Initial Professional Development or IPD);
- Passing Professional Review.

CEng- Chartered engineer in the UK is the highest qualified engineers in their field. The title CEng is protected by law, is one of the most recognisable international engineering qualifications. This means that the educational requirements are demanding and an asset.

- An accredited four-year integrated MEng degree
- A bachelor's degree which is accredited as CEng with further learning, plus an accredited master's degree.

Having one of the above means a person already have the needed for CEng. These courses are accredited after the Joint Board of Moderators (JBM) formally visits the universities that offers the course to ensure that the courses at the right standard and they covers core subjects, such as materials, geotechnics, fluid mechanics and structures.

The Initial professional Development (IPD) is where a junior engineer develop special skills, knowledge and experience that help him become professionally qualified. The IPD is measured against a set of 'attributes', which a can be achieved in three stages:

- Knowledge – a basic understanding and knowledge of the attribute and how an engineer achieve it.
- Experience – achieving the attribute in different situations, working under supervision.
- Ability – achieving a level assisting others and working unsupervised.

The professional review is the final stage in becoming professionally qualified. Where developing all the right skills is a considered proof of qualification. Review itself is made up of three stages:

Initial application – brings the information to the ICE table to start arranging the applicant Professional Review.

Submission – a produced report up to 5,000 words showing the applicant meets all the requirements to become incorporated or chartered engineer.

Professional Review – an interview done by experienced civil engineering professionals. Report discussion and show of knowledge. A written exercise has to be completed which is an assessment of the applicant's written skills [19].

Figure 2.1 - Requirments needed to become professionally registered (ICE) [20]

2.4 Responsibilities and guarantees from a civil perspective

The basic purpose of building regulations is to ensure the structural and fire safety, as well as the aesthetic value of the structures, installations, and surroundings, as well as the safety and health of the users [21].

There are no standards for all European countries that specify the general rules for the construction site managers, but in the other hand European countries are set to a few ground rules that shapes and defines the work in the construction sector.

The overall goal of the legislation is to maintain the health, solidity, and aesthetics of structures, installations, surroundings, and their safety. European government authorities that offered building construction instructions were divided between federal (generic basic rules) and regional agencies (specific rules). Local authorities can establish rules, and some of the bigger authorities (cities) focus on planning and environmental issues. On a technical level, there are no comprehensive construction regulations in existence. Various governmental agencies, particularly at the federal level, and departments have established technical requirements and regulations, mostly addressing safety and health [21].

3. Public and private construction projects

Private and public building legislation is becoming extremely valuable in the construction business. Civil and structural engineers' daily working practices are now dominated not only by difficult technical challenges but also by legal issues. Dealing with the law affects everyone participating in a construction project, which is why understanding legal risks, such as the construction timetable in leadership and managerial expenses, will become more vital [22].

3.1 Principal concepts and definitions

Work Director "Construction site manager" is the qualified professional who make sure that the works are executed according to the project and, when applicable, that conditions regarding the licence or the prior notification are met, and that the applicable laws and regulations are complied with. Their work involves: ensuring the technical supervision of the works and the coordination of the whole production activity, in case their employer company is responsible for the execution of the construction works; adopting the appropriate production methods, in order to ensure compliance with their legal obligations as well as work quality and safety and efficiency within the construction process; ensuring that the project is correctly implemented, by coordinating, supervising and carrying out the works according to the project and complying with the requirements for obtaining a licence or entering in the construction industry, in the context of an administrative or public contractual procedure [23].

In order to proceed with this work, it's important to identify and define more civil concepts, names, and terms other than just the "work director". For the effect of the decree law nº 41/2015 announced by the Portuguese republic assembly it's understood by [24]:

a) License building permit «Alvará»: It's a permission, issued by the Public Market Institution of Real estate and Construction (IMPIC, I. P.), in digital format checkable by consultation in its corresponded internet site. This document authorizes the construction company to realize the project and its specialized works, which its value does not exceed what was estimated for its respective class, where it was referred at the public work, been understood in the elanced subcategories;

b) Construction activity: The activities that its objective is to realize the work and do its necessary actions in their concreted disposition.

c) Category: The diverse types of construction projects and specialized works met in the qualifications of the public works contractors;

d) Work Owner: the entity for whom the construction work is realized. While the public work owner is the concessionaire in relation to work executed based on a public works concession, as well as any person or entity that contracts the elaboration of a work project;

e) Particular work contractors «Empreiteiro de obras particulares»: a single person or a collective qualified to execute the promoted works by private entities;

f) Public work contractors «Empreiteiro de obras públicas»: a single person or a collective qualified to execute the promoted works by public entities;

g) Sub-categories: the specialized works or works into which the categories are divided, included in the qualifications of public works contractors;

h) Sub-contraction: the contracting out, from one construction firm to another of the execution of the works awarded to it by the owner of the works.

3.1.1 Project management

- Project is the name given to a set of written and drawn documents that define and characterize the functional, aesthetic, and constructive design of a work, including the architectural design and engineering projects in particular [25].
- The management of a project is the effective and efficient coordination of resources of different types, such as human, material, financial, and political, the pre-established parameters of time, cost, quality, and risk.
- On the other hand, managing a project is to ensure that it is planned at all stages, allowing, through control mechanisms, continuous surveillance where the impacts of deadlines and/or costs are analysed and projected for a short and medium-term horizon, making it possible to anticipate management decisions that guarantee the execution of the project in the desired time.
- Overlapping phases during project development requires management to monitor the components of each phase, as well as coordination of interfaces between them so that nothing is lost in the transposition from one phase to another, always aiming to achieve the objectives set in the project.
- The management of a project creates an entrepreneurial attitude to coordinated work, in which organizational behaviour is fundamental to the success of group work and which develops, at the same time and under a single basic guideline, different activities with common objectives.
- The management of a project requires the maintenance of a motivated team, identified with the objectives of the project and with the full mastery of business

expectations. It implies the establishment of a flexible organizational structure and compatible with the requirements for the operationalization of the project. And finally, you need an integrated management information system that allows you to several functional levels of decision-making.

- The management of a project, by the typical activities that are developed in it, can be classified into mid-activities and end-activities [26].

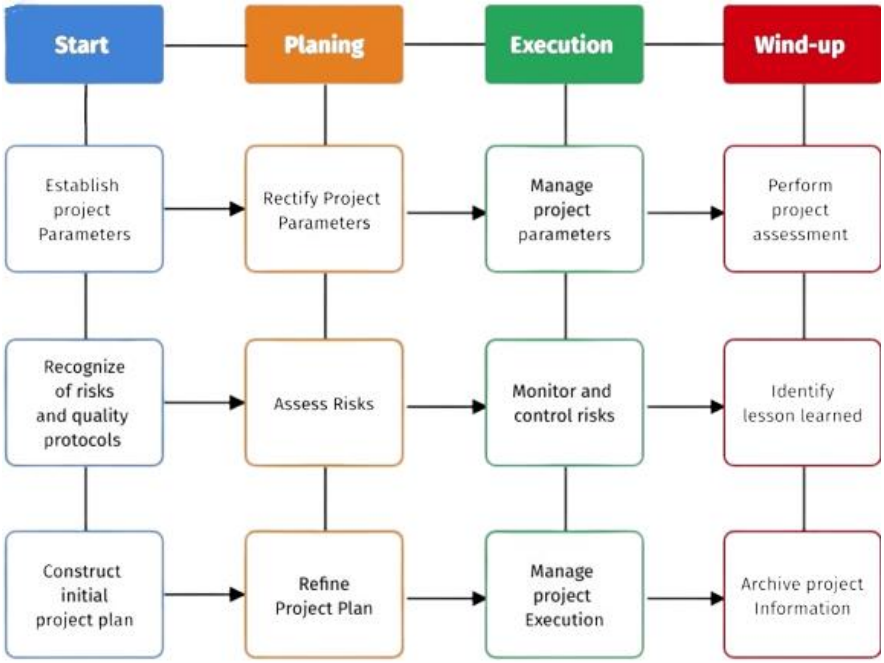

Figure 3.1 - Project management process [27]

The coordination of the activities of the participants in the project aims to integrate their different parts into a harmonious set of actions, easy to interpret and able to provide all the necessary elements for the execution of the work, ensuring the proper articulation of the project team according to the characteristics of the work and ensuring the participation of the technical authors, the compatibility between the various necessary projects and compliance with the legal and regulatory provisions applicable to each speciality, as well as the relationship with the Owner or his representative [25].

3.1.2 Construction projects categories

Construction works are classified as the higher or lower level of its conception and degree of project's complexity, in terms defined by the numbers according to the Annex - C of the ordinance nº 701-H/2008 on 29 of January [25]:

1. Category I: includes works of a simple nature in which the following characteristics are dominant:
    a) Easy design and conception by the simplicity of satisfaction of the programme of functional requirements;
    b) High degree of repetition of the different component parts of the work;
    c) Current Systems or execution methods.
2. Category II includes the works with current characteristics where are predominant the following aspects:
    a) Simple conception, based on functional programs with current requirements;
    b) Installations and equipment that correspond a solution without any specific complexity;
    c) Low degree of repetition of different component parts of the work;
    d) A solution of a design and construction without and special conditions of costs.
3. Category III includes the works where the elaboration of the project is conditioned relatively with current works, by few of the following factors:
    a) A conception based on functional programs with special requirements;
    b) Technical installations with their complexity that turns the necessity of a study of less current solutions that require elaborated solutions od compatibility with the different parts of work's components;
    c) Research obligatory of various solution that leads to new systems and methods and the application of materials and different construction elements of current works;
    d) Integration in natural context or constructed with the determination of relevant requirements, corresponds in particular to aspects relating to environmental contexts or exceptional visual, historical;
    e) Special obligation of artistical or technical invention of the program;
    f) The obligatory research of solutions that guarantee a reduced cost contention.
4. Category IV Consists of works with impositions and severe characteristics more than the previously mentioned categories, where the research of individual solution is dominant.

Those projects that their works require actions' execution in exceptional circumstances, for example, with accident risks, harsh climate, shortened deadlines, or needs a new conception responsibility or uncommon construction methods. Can be classified in superior categories of their correspondent without the occurrence of such circumstances [25].

3.1.3 The construction process

The construction industry in recent decades has evolved rapidly to accompany the changes in our society in multiple domains. On the one hand, the requirements of users of the construction process in terms of safety, comfort, use and durability of constructs have been responsible for these mutations. On the other hand, technological aspects, related to the way of building and the labor employed in the construction have been fundamental in these changes.

Currently, the projects are designed and executed for a durability age of about 50 years. Since the objective of the construction is to carry out works that satisfy the users' needs, their materialization is based on a set of activities, carried out in various phases that can be visualised in five major phases in which the works are normally undertaken, as well as the main stakeholders in each of these.

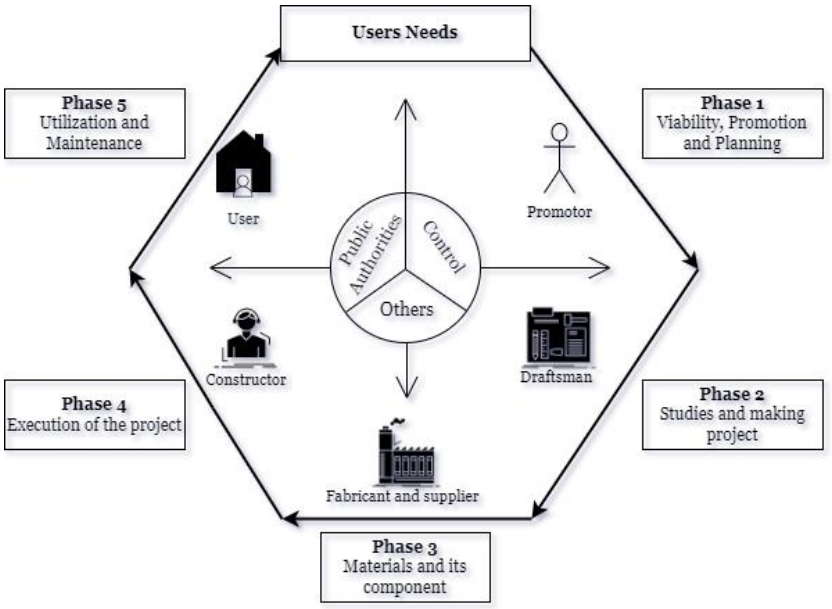

Figure 3.2 Synthesis of the construction process. Adapted from [28]

Civil engineers together with other technicians, tend to be professionals in the construction field therefore they must have a global vision of the constitutional phases of the construction process, its goals, and main actors [26].

As the (Figure 3.2 Synthesis of the construction process. Adapted from [28]Figure 3.2) shows the construction process according to Prof. Lanzinha model starts with: [26]

1. Phase 1: Promotion, viability, and planning. Where the main intervener is the promotor or their representative like the stakeholder or owner himself. The responsible of most of the project, establishing its objectives, study the impact and analysis of the engaging elements, Decide the economical and the project's viability, organize the preliminary program. The owner should define the contractual framework if doing the construction work, also choosing the project manager if existed, contract draftsmen team, admitting that this process would be the "Traditional way".

2. Phase 2: It is about the studies and projects. At this stage, the designers' team will develop the construction project using the "traditional" process chosen by the Owner of the work, with the needs and indications of the promoter stated during the first stage, in the Preliminary Program, as a starting point. At first stage, a few essential factors are decisive. The fact that the constructions are designed to meet the needs of customers is emphasized. for a given investment and should therefore prioritize its aims as much as possible. Designers must make their creative process consistent with the target purpose to accomplish this. Another critical issue is the degradation/maintenance and aging of the structures, and This requirement must be given special consideration when carrying out the project. Finally, the project activity is a multidisciplinary activity that requires indispensable but is difficult to coordinate, developing through consecutive iterations from the general to the specific. Processes that are too rapid, too simple, or too poorly coordinated usually result in problems in the workplace.

3. Phase 3: The third stage is concerned with both material and component selection. This step is directly related to the previous phase (Studies and Projects) in that the selection of Materials and Components is carried out during the design phase via the technical specification, which shall specify the materials and components to be used and how they are used. This third stage is also related to phase four (Work Execution), because it is during the construction that suppliers and purchases of materials will be accomplished, and the compatibility of the same with the technical specification, as well as its suitable application, must be checked. It has become widely recognized that the industrialization of construction is required for increased

productivity, profitability, and the achievement of stable quality standards, goes through a role and increasing importance of the industries of materials and components that are integrated with construction.

4. Phase 4: In the fourth stage of the execution work is a set of intermediate stages:
    - Consultations and contracting
    - Materials and machines warehouse and preparation of construction
    - Construction and development of the project
    - Reception of works

Following market consultation, the work is usually awarded to a contractor who is responsible for its execution as well as everything that is directly related to it, such as the implementation of the construction site warehouse and the Work, preparation, and planning of the same, ordering and verification of the conformity of the materials to be used in work, and for the execution itself until the work is received.

The Safety and Health Plan is critical at this stage of construction execution, and the contractor is responsible for detailing and complying to it. In addition, when planning and preparing the work, the contractor must verify that the timeframes and quality specified in the project are met, as intended by the owner. The Safety and Health Plan is critical at this stage of construction execution, and the contractor is responsible for detailing and complying with it.

In addition, when planning and preparing the work, the contractor must verify that the deadlines and quality specified in the project are met, as intended by the owner. Usually, the works have a general contractor to whom all (or nearly all) of the work is assigned. Currently, the general contractor subcontracts other companies, usually corresponding to the various specialities, making the general contractor the manager of a group of smaller companies, mainly ensuring deadline compliance while being less concerned with the quality of the work execution. The primary purpose of receiving the work is to demonstrate that the work completed meets expectations. Associated with this phase we can have final tests of materials and systems, cleaning, and experimental start-up of the work. In general, the reception is divided into two phases:

i. The Provisional Reception coincident with the end of the work, which marks the beginning of the warranty period.

ii. The Definitive Reception that will occur at the end of this period, and this term is currently, if another is not contracted, 5 years. During the warranty period, the Contractor is liable for any damage incurred in connection with the Work that is directly related to its improper performance.

5. Phase 5: The final phase of the construction process is known as use and maintenance, and it is the most time-consuming. Users have duties from the start of use, and these responsibilities increase after the warranty period expires. Although traditionally a less technical stage, it is now recognized that technical actors in the construction process must follow the work they have done in order to process information for future interventions, and the need for qualified technical support for building management, conservation, and maintenance is indisputable. This last phase would be the determinant of the service life of the work, depending on multiple factors.

In the construction process that has just been described the moment that is hired the builder is not always the same. In the so-called traditional solutions, the construction is based on a complete project that is used in a concourse and in the realization of the work. This project was commissioned by the owner, who for this purpose hired an independent design team of the builder. There are those who argue that this solution attributes much roleplay to the designer, the more that it can be said that the contractor may at first be the agent that has a greater perception of the constructive possibilities and their costs.

On the other hand, it can be argued that builders lack the technical capacity to define the functional and spatial requirements of the construction, requiring the use of an independent conception and design service, especially given that most contractors lack the technical capacity or project culture to develop and propose the best constructive solution. However, there may be several intermediary scenarios relating to the type of roleplaying assumed by the contractor between these two points of view. This procedure is illustrated in (Figure 3.3).

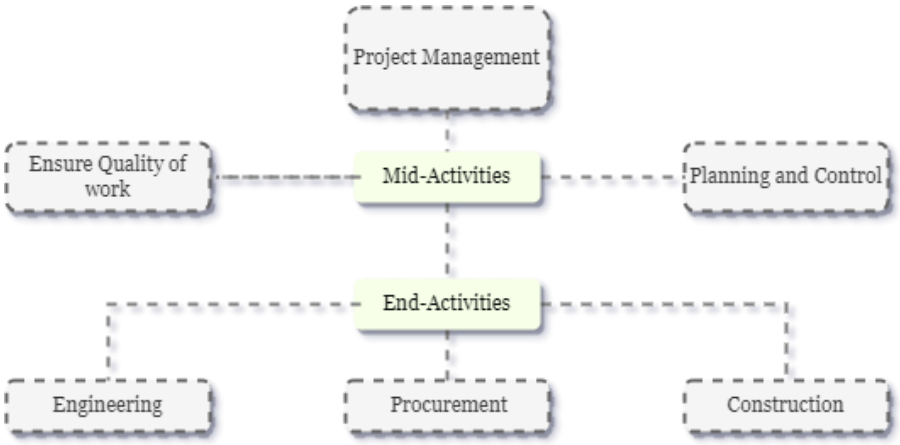

Figure 3.3 - Project management typical activities [28]

3.1.4 Public work projects

In Portugal, the Public Contracts Code (CCP), was found and written as a transposition of the directives nº 2004/17/CE and 2004/18/CE both established by the European Parliament and the council EC. The law approved the Public Contracts Code that establish the applicable disciplines on a public contract and the substantive regime of public contracts that are in the nature of an administrative contract.

A very important historical mark in the evolution of the administrative national direct and, in specific in the contractual activity of the administration. It proceeds to a new systemization and uniformization of the substantive regime of public contracts that are atomized till now.

The article nº 43 of the CCP that define the missions' notebook (caderno dos encargos) of the formation procedure of the contractors' contract of the public work should be integrated with a programme and execution project. The fact that are many public works that goes through anterior phases made it more important to regulate [25].

3.1.4.1 Instructions for the public projects work elaboration

The 701-H/2008 on 29 of January ordinance paid more attention to the requirements and demands in the public work projects' elaboration, due to this some essential steps were developed, understood by:

a) «Pre-Project», or base project;

b) «Technical assistance»;

c) «Special technical assistance»;

d) «Project's author»;

e) «Project coordinator»;

f) «Health and security coordinator in project phase»;

g) «Work's owner»

h) «Work contracting/subcontracting»;

i) «Project's team»;

j) «Previous study»;

k) «Project's pieces»

l) «Base program»;

m) «Prelaminar program»;

n) «Recognition program»;

o) «Draftsmen»;

p) «Project»;

q) «Final blueprints»;

The majority of these step concepts are indirectly related to the construction manager tasks. The more accurate and understandable those tasks are done the more the job of the construction manager gets smoother and achievable with the least mistakes possible. Also, the better understanding from the manager the better the works on-site are done. Execution process is very sensitive and always needs a well-focused head running the teams in action.

For the planning effects, the project's phases, and its weight importance, shown in the following table in percentages:

Table 3.1 The Importance of the Project Phases [25]

Project's Phases	**Percentage**
Base Program	10
Previous Study	20
Pre-Project	20
Execution Project	35
Technical assistance	15

The fact that the execution project and its application in the field has the most importance in terms of planning, clearly putting more pressure on the construction site manager while the execution process, and it give almost zero space for even small technical errors.

3.2 Construction activity

3.2.1 Construction firms' obligations

For the sake of doing an excellent work the contractors of public work based in Portugal should have and meet the conditions established by the IMPIC depending on their licence permit. Some of those conditions are related to directorial aspects like the license's type, certificate, and commercial suitability and some are technical as the adequate qualifications. Where the construction firm responsible of the public project must hold a qualification containing a subcategory in a class that covers the global value of that, respecting the most expressive works of it, without prejudice to the requirement for a qualification in other classes and subcategories relative to the remaining works and jobs to be carried out [24].

3.2.2 Construction firms exercising its activity

1- Each construction company must demonstrate to IMPIC, I. P., the necessary technical capacity, translated into human resources adequate for the construction, project management, and management of health and safety at work.

2- The minimum number and qualifications of the technicians who grant their technical capacity to construction firms, who must be linked to them by employment or by service provision.

3- It is expressly forbidden for technicians who provide service in national entities of control of execution of works, or a public work owner in the national territory, to perform functions in construction companies registered in the IMPIC, I. P..

4- Construction companies must execute the works under their responsibility in accordance with what they have contracted and in compliance with the legal and regulatory provisions applicable to them.

5- Construction companies must execute the works under their responsibility in accordance with what they have contracted and in compliance with the legal and regulatory provisions applicable to them.

6- The following constitute, namely, a breach by construction companies of the provisions in the above number:

a) The malicious recording in the measurement records of works not carried out;

b) Failure to comply with the deadline for the execution of the work or the abandonment of the same, for imputable reasons to the company;

c) Failure to comply with the legal norms relating to safety hygiene and health at the construction site.

7- In all contracts subject to Portuguese law, as well as in accounting documents, publications, advertising and in their correspondence, construction companies must indicate their company name and the permit or certificate number they hold.

8- Construction companies must affix, in a clearly visible manner, at the access point to the construction site of each work for which they are responsible, an identification plate with their company name or corporate name and the permit or certificate number that they hold.

3.2.3 Construction site manager

Generally, the site manager (work director) intervenes in functions immediately before the effective beginning of the work, after the enterprise had won the concourse's contract for the project realization, or after the execution decision has been taken for a given project. This preliminary phase could be described as the work preparation [29].

Another definition by the Portuguese Republic Assembly where the work director is the qualified technician that entrust to securing the work execution, complying with the execution's project, and when applicable the licence conditions of the previous communication, well also meeting the legal and regulatory norms in a precise way [30].

3.2.3.1 Construction site manager competencies

The site manager is the person who competes leading the construction work in all its administrative, technical, and economical, being responsibility of completing all the clauses of the contract, the charges notebook, and the rest of the missions, these constitute the work process, according to the norms and its precise disposition. Also, the work's execution mode orientation is attributed as responsibility, yet to ensure the security in the site and for all the working people there [29].

3.2.3.2 Construction site manager principal functions

- Labour workforce;

- Materials;
- Equipment;
- Subcontracting;

3.2.3.3 Construction management principal areas

The construction director must deal with different types of fields while directing, most importantly the following:

- Costs and;
- Time and schedules;
- Quality of work;
- Heath and security of people in-site;
- The ambient of the working place and maintaining cool and smooth process.

3.2.3.4 Productive resources management

There are three fundamental management phases considered to the site director:

1- Initial preparation of the construction site and the project plan.

2- General coordination of the construction execution.

3- Directing the team of work management.

These functions and fields in the manager list of duties are written and described in a very clear way, in the Portuguese legislation decree law "Public Contracts Code", explained and detailed in the next paragraphs.

3.3 Public contracts code (CCP) in Portugal

3.3.1 Public work contractors

1- As it was described previously in the work, the enterprise of public contract is an onerous contract that its object either the execution or the joint execution and design of a public work falling into the subcategories referred to in the regime for starting and remaining in the construction activity.

2- For the purposes of the preceding paragraph, public work is considered to be the result of any work of construction, reconstruction, extension, alteration or

adaptation, conservation, restoration, repair, rehabilitation, improvement, and demolition of real estate property executed on behalf of a public contracting entity.

3.3.2 Parties and their directorial tasks

1- Are parts in the agreement of a public work, the work owner, and the contractor.

2- During the execution, the work owner is represented by the construction inspection manager, in all aspects related to the work, and by the contract gestor, in all the other aspects related to the contract execution, the Contractor is represented by the site manager, with exception of matters in which, by law or by contractual stipulation, a different mechanism of representation is established.

3- Without prejudice to other limitations provided in the contract, the construction inspection manager and the contract gestor have no powers while representing the owner of the work in matters of modification, solving, or revocation of the contract.

4- In the absence of contractual stipulation, during periods in which they are absent or impeded, the site inspection manager, the contract manager and the construction site manager shall be replaced by the persons that they indicate for that purpose, provided that, in the case of the site inspection manager, the designation of the substitute is accepted by the owner and communicated to the contractor.

3.3.3 Administrative guarantees by the contractors

The contractors or specifically the site manager should put in a formal manner the actions done related to the work like measurements and unitary costs applied as contracted on monthly basis, it's called the auto.

1- The contractor has the right to complain or to present reservations concerning the content of the acts referring to the work that must be formalised in a report.

2- Complaints or reservations may be expressed in the record itself or presented within 10 days after its notification to the contractor or may be limited to a generic statement of the respective object, in which case the contractor may present a reasoned written statement within 15 days. whereby silence is considered as acceptance of the complaint or acceptance of the reservation from both parties.

3- The report is reduced to writing and signed by the representatives of the parties and handed to the construction director.

4- If the site manager refuses to sign the report, it shall mention this fact and the reason for the refusal and the owner's representative shall promote the signature of the report by two witnesses that confirm the occurrence.

5- If without justification under the terms of this Code and due to a fact that can be imputable, the work owner does not formalise in the report any act that is subject to this formality, such omission cannot be enforced against the contractor.

3.3.4 Workplace order maintenance (Site Environment)

As mentioned, one of the tasks of the site manager is to maintain a good work ambient at the same time directing the workforce. For the effect of the anterior statement, the contractor's representative must dismiss from the work site, on his own initiative or immediately after the order of the owner of the work, any personnel who have behaved in a disruptive manner, in particular by working in poor performance doing their duties, by indiscipline or by disrespecting the representatives or agents of the owner of the work or the representatives or agents of the contractor, subcontractors or third parties.

3.3.5 Preparation's work and accessories

In the absence of contractual stipulation, the contractor has the obligation realizing all the work that by nature, legal requirement, will be considered as a preparatory or accessory for the construction work, by description:

a) Works like assembling, construction, maintenance, dismantling and demolition of the construction site;

b) Works necessary to ensure the safety of all people working on the site or circulating on the site, including the staff of subcontractors and third parties in general, to prevent damage to neighbouring buildings and to comply with safety, hygiene, and health at work and public road police regulations;

c) Works for the re-establishment, by means of provisional works, of all the servitudes and usefulness which it is essential to alter or destroy for the execution of the works and to avoid the stagnation of water that such works may cause;

d) construction works for access to the work site and for the internal services that it provides.

3.3.6 Work's execution

3.3.6.1 Work plan

1- The plan of works is intended, in accordance with the deadline for the execution of the work, to fix the sequence and the partial deadlines for the execution of each type of scheduled work and to specify which the contractor proposes to execute it.

2- In the case where the contractor is under a contractual obligation to elaborate the execution programme or execution project, the work plan includes the supply of the project services under the responsibility of the contractor.

3- The work schedule contained in the contract may be adjusted by the contractor to the final consignment plan submitted by the work owner.

4- The adjustments referred to in the previous paragraph cannot imply changes in the contractual price, changes in the deadline for the execution of the work, nor changes in the partial deadlines defined in the work plan included in the contract, beyond what is strictly necessary to adapt the work plan to the final consignment plan.

5- The adjusted work schedule must be approved by the client (Work owner), within five days after notification by the contractor. Where the silence in such a situation means acceptance of the work plan.

3.3.6.2 Payment plan

1- The payment plan contains a quantified and phased by time, of the value of each type of work to be performed by the contractor, at the intervals defined for the payments to be made by the developer, in accordance with the work plan to which it relates.

2- The payment plan is completed for approval by the construction owner before the date of completion of the total consignment or the first partial consignment and may not result in changes in the overall values for each component of the work presented in the presentation of proposals.

3- In any situations in which it is necessary for the current work plan to be changed for reasons not attributable to the contractor and which are duly justified, the contractor must submit a payment plan adapted to the new work plan, and the owner of the work must comment on the revision of the payment plan within the indicated period in no. 5 of the previous article, and silence is equivalent to acceptance.

3.3.6.3 Execution deadline

1- The period of execution of the work begins from the date of conclusion of the total consignment or of the first partial consignment, or from the date on which the owner notifies the contractor of the approval of the safety and health plan, under the terms provided for by law.

2- In cases where the contractor has the obligation to prepare the execution project, the contract may establish deadlines for the preparation and delivery of the relevant project elements with a final deadline prior to the consignment date.

3- In the case of the previous number, the contract must establish maximum time limits for the client to give its opinion about the project elements delivered by the contractor so that the execution of the work is not prejudiced by delays in the appreciation that is incumbent upon the owner of the work on such project elements.

4- In the absence of contractual stipulation, the execution time of the work referred to in number 1 is understood to include the conception phase, whatever its content.

3.3.7 Work suspensions

1- In contracts that provide for a period of performance of the work equal to or greater than one year, the contractor may suspend, once each year, in whole or in part, the execution of the works for a period not exceeding 10 consecutive days, provided that the owner of the work does not object expressly and the partial deadlines and the final deadline for the execution of the work are not compromised.

2- The contractor must be responsible for any additional costs arising from the suspension provided for in the previous number.

3- In addition to the general grounds for suspension provided for in the public Code and others provided for in the contract, the contractor may suspend, in whole or in part, the execution of the works in the following cases:

   a) Lack of safety conditions;

   b) Failure to pay any amount due under the terms of the contract, as long as one month has elapsed since that month payment.

4- Suspension by the contractor must be anticipated by written communication to the owner of the work immediately after the occurrence of the event that justifies it, with express mention of the ground invoked and the facts that concretize it.

5- In the case of point b) of nº. 3, the communication referred to in the previous paragraph shall be not less than 15 days prior to the suspension and the normal

development of the work plan must be guaranteed, and it shall be prejudiced if, by the end of the period referred before, the owner pays the amounts in debt.

6- When the urgency or the need for immediate suspension is incompatible with the requirement for prior written notice, the notices referred to in the previous points may be given orally, and the site manager must formalise them in writing within the following five days.

3.3.8 Complementary work

1- Complementary works are those whose kind or quantity is not foreseen in the contract.

2- The owner may order the performance of complementary works to the contractor when the change of the co-contractor:

   a) Cannot be carried out for technical reasons, namely due to the need to ensure interchangeability or interoperability with existing equipment, services, or facilities; and,

   b) Produces a considerable increase in costs for the owner of the work;

3.4 Private contracts code in Portugal

3.4.1 Legal Regime of Urbanization and Building (RJUE)

Recent legislations currently in force was not able to be compatible with the safeguard requirements of the public interest with the administrative efficiency that legitimately aspire the citizens. In order to fulfil this necessity a review of the legal regime of municipal licensing of urban lots and urban and particular projects. If certain, by way of increased particulars responsibility, it's possible to lower the administrative control intensity that actually is subjected for certain urbanistic operations projects, respecting the previous respective control protocol, this cannot be nor should mean less administrative responsibility.

The regime covers the developed activities by public and private entities in all the phases of an urban process, from effective soil allocation to urban construction until the use of buildings implanted in it. The Institute of Construction and Real Estate, I.P. (InCI, I.P.) is the regulatory body for the construction and real estate sector. It is up to it to assign the titles for the exercise of the regulated activities, namely, Building Permit, Registration Title, Real Estate Mediation License and Real Estate Fundraiser Registration.

Its action aims to enhance a modern and competitive construction and real estate market through effective inspection and inspection action [31].

In order to proceed with this work, it's important to identify and define more civil concepts to better understand the establishment of the legal regime of urbanization and building [31]:

Types of urban construction projects:

a) «Building», the activity or result of the construction, reconstruction, expansion, alteration, or conservation of a property intended for human use, as well as any other construction which is incorporated into the soil on a permanent basis;

b) «Construction works» means the creation of new buildings;

c) «Reconstruction works» means construction works following the total or partial demolition of an existing building, which results in the reconstruction of the facade structure;

d) «Alteration works» means works resulting in the modification of the physical characteristics of an existing building, or its fraction, in particular its resistant structure, the number of fires or interior divisions, or the nature and colour of exterior cladding materials without increasing the total construction area, deployment area or facade height;

e) «Expansion works», the works resulting in the increase of the implantation area, the total construction area, the height of the facade or the volume of an existing building;

f) «Conservation works» means works to maintain a building in the conditions existing at the time of its construction, reconstruction, extension, or alteration, in particular restoration, repair or cleaning works;

g) «Demolition works» means works of total or partial destruction of an existing building;

h) «Urbanisation works» means works for the creation and refurbishment of infrastructures intended to directly serve urban spaces or buildings, such as road and pedestrian streets, sewerage and water, electricity, gas and telecommunications networks, green spaces, and other spaces for collective use;

i) «Subdivision operations» means actions having as their object or effect the constitution of one or more lots intended, immediately or subsequently, for urban construction and resulting from the division of one or more buildings or their repairing;

j) «Urban planning operations» means the material operations of urbanisation, construction, and use of buildings or land provided that, in the latter case, for purposes not exclusively agricultural, livestock, forestry, mining or public water supply;

k) «Works of little urban relevance» means works of construction or demolition which, by their nature, size or location have little urban impact;

l) «Land remodelling works» means urban development operations not included in the preceding subparagraphs which involve the destruction of the vegetation overlay, the alteration of the natural relief and the layers of arable soil or the large or massive trees for purposes not exclusively agricultural, livestock, forestry, or mining purposes;

m) «Consolidated urban area» means an area characterised by an occupation density which allows the identification of an already defined urban network or structure, where the essential infrastructures exist and where the alignments of the marginal plans are defined by buildings in continuity.

n) «Forced rental» means the rental of buildings or units, taken over by an administrative entity, by a period strictly necessary for this purpose, in order to guarantee the reimbursement of expenses incurred with the execution of coercive works, through the receipt of rents related to a contract previously existing to the intervention that remains in force or, when it does not exist or has expired, by the conclusion of a new contract.

3.4.2 Construction site manager in power

The holder of the building permit and presenter of the prior communication shall be obliged to be affixed on a plate in imperishable material outside the building or to engrave on one of its external elements the identification of the director of work.

3.4.2.1 Authorisation of use's application

One of the utilisation request's instructions is the application for authorization of use must be instructed with the final blueprints, accompanied by a term of responsibility written by the construction director or the work inspection director, in which those must declare that the work is completed and that it has been executed in accordance with the architectural and speciality projects, as well as the approved exterior arrangements and the conditions of the respective prior control procedure and that the changes made to the project are in accordance with the legal and regulatory standards applicable to it.

When the authorisation is to be granted and inserted with the term of responsibility that defines the required professional qualifications of the technicians responsible for the project's elaboration, is exempt from carrying out a municipal inspection, as well as the presentation in the city municipality of certifications, approvals and external technical opinions, the communication of the conclusion of the work would be sufficient, accompanied by a signed declaration of the author of the project and the construction director or construction inspector, from which such elements were obtained.

The municipality inspection has a deadline of 15 days counting from the day the decision taken made by the municipality president, occurring always according to the date of the applicant which in this case is the construction manager as mentioned before in this subparagraph.

The realization date of the inspection is notified by the city municipality to the authorisation of use's applicant, which takes a place in-site accompanied by the project's author and the responsible technician of the work management, which they participate in without having the right to vote for the inspection [31].

3.4.2.2 License expiry date

The license or the prior communication for the realization of the subdivision operations that requires an urban construction realization, expires when:

1. If the construction site was abandoned for periods superior to six months;
2. The works presume abandoned in case of the construction site manager's absence [31].

3.4.2.3 Enforcement and work initiation

Important information about works starting and their responsible ones:

1. Until five days before the work's initiation, the promotor (contractor) informs the city municipality about its intention, also communicating the people identities, singular or collective, the responsible of the work execution (Construction director);
2. The construction director is obligated to execute exactly as the projects, with respect to the license conditions or any prior communications;
3. The construction work execution subjected to a license in the terms of previous information only can be initiated after the building license emission;

4. Works subjected to prior communication can be initiated after all fees in debt have been paid.
5. Any urban work only can be started after all technical opinions, authorisations emissions, or after the fixed dates and time frame for its respective emission.
6. In a period of sixty days counting the commencement of the works related to urban operations, the promotor (contractor) should present to the city municipality a copy of specialities and other studies related to the pretended project.

3.4.3 Execution of a project's works

3.4.3.1 Project's plan alteration while execution

The alterations of a project on-site could be realized upon a prior regulated communication led by the president of the city municipality informatically via an electronic platform, such notification should be made in necessary advance in order for the works to be concluded before the authorisation of use application is inserted in the final blueprints. Sometimes changes on-site that don't correspond to projects that were subjected to prior control can be conducted without prior communication with the city council.

The alterations of expansion or alteration works already approved are subjected to procedures as license conditions changes if the interested party has applied for it. In all the previous situations only the instruction elements that suffer changes are presented.

3.4.3.2 Work conclusion and reception

- Work concluded, the site manager is responsible and obligated to proceed in construction site removal, cleaning the area according to the management regime of residuals produced form the construction and/or demolition works, and the repairing of any damages and deteriorations caused in the public infrastructure around.

- Compliance with the provisions of the previous paragraph is a condition of the issuance of the permit for authorisation of the use or provisional reception of the urbanization works, unless it has been provided, within a period to be fixed by the city council, a security deposit is held to ensure the performance of the operations in the construction site [31].

3.4.3.2.1 Provisory and definitive reception of urban development projects

- It is the municipal council's responsibility to decide on the provisional and final acceptance of urbanisation works after they have been concluded and the guarantee period has elapsed, respectively, upon request by the interested party.

- The provisory and definitive reception, as well as the municipality inspection. With the necessary adaptations, the public works contracts' reception is applicable here also.

- In the event of a deficiency of the urbanization works, as indicated in the municipality inspection report, if the owner of the urbanization works does not claim or his claim is refused and does not correct it within the time limit set for that purpose, the municipality shall act in accordance with the law and fine the license holder (Construction manager) and promote the work realisation on behalf of him.

- The warranty period for urban development projects is five years.

3.4.4 Workbook diary

- All relative facts related to the licensed project execution or tools of prior communication should be registered by the construction manager in the workbook diary and kept on the site in case of any consultation by the municipality officials responsible for the construction site inspection.

- Initiating and conclusion dates are to be registered obligatorily in the diary, all the facts that imply the work programme or its suspension, as well as the alterations that were done in the project licensed or communicated.

- The model and all the registers rested to be written in the diary are defined by a joint ordinance of the government responsible for public works and land-use planning, which also establishes the characteristics of the electronic workbook diary.

3.4.5 Urbanistic projects sanctions and civil responsibility

3.4.5.1 Administrative offences

The civil responsibility, criminal or disciplinary are punished as against-ordinance or an administrative offence if the following took place:

a) The false declarations in the responsibility term of the construction manager or the inspection manager or any other relative technicians. This case could reach a punishment fine gradually between 1500 (euro) till 200,000 (euro).

b) The workbook diary is missing in-site where the project is being executed.

c) Missed registrations or not noted situations of the executed project in the workbook diary.

d) In the case of the construction manager's absence or changes, the absence of the solicitation request to the municipality council to substitute the complainant, the project author, the construction manager or the inspection director.

The following table (3.2) shows how much a singular or corporate/legal body could be fined if any of the above lines happened:

Table 3.2 Regulated penalties values set by the municipality council [31]

Issue	Fine amount (€) from	Fine amount (€) to
a)	1.500	200.000
b)	Singular: 250 Corporate: 1.000	Singular: 50.000 Corporate: 100.000
c)	Singular: 250 Corporate: 1.000	Singular: 50.000 Corporate: 100.000
d)	Singular: 100 Corporate: 500	Singular: 2.500 Corporate: 10.000

3.4.5.1.1 Accessory sanctions

The sanctions applied under the provisions of issue nº a) of the anterior paragraph to the project authors, responsible for the construction site management or whoever subscribed to the responsibility term are communicated to their respective order or to their professional association if existed.

3.4.5.2 Criminal responsibility

- The Failure to comply with administrative acts that determine any of the urban tutelage legality measures provided in the private contract's code constitutes a crime of disobedience under the terms of Article 348 of the Portuguese Criminal Code.
- The false statements or information provided by the responsible persons (Construction manager), in the terms of responsibility or in the workbook diary integrate the crime of falsification of documents, under the terms of Article 256 of the Portuguese Penal Code.

As a civil liability the construction managers are responsible in the case of urbanistic operations that are incompatible with the applicable territorial management instruments [31].

4. Characteristics related to leadership, organization, planning, Safety, and support instruments to the process

4.1 Key Points in Safety Supervision and Management of Construction Site

One of the principal functions and main areas of the construction manager is controlling the workforce and to ensure the health and safety of people on-site.

Construction projects must be carried out efficiently while ensuring construction site safety. Construction site safety management is the key to the progress of construction projects and a sign of good development in the construction engineering industry. Therefore, the construction sector should properly manage the safety surveillance of construction sites. Currently, the government and other relevant agencies also attach great importance to the rights and benefits of migrant workers working on construction sites. The construction industry should take appropriate measures to consider safety control measures at construction sites for factors and legal regulations that affect construction safety. This creates a constructive basis for the smooth implementation of building construction [32].

Companies also need to integrate security design into their development strategy and raise awareness. Promote employee attention to safe production and safe construction of enterprise construction projects. Based on this, the construction industry should continuously improve its overall safety management strategy from the actual construction site. It strongly supports construction site management and project implementation by applying management methods and management methods and promotes the construction of project safety management [32].

In the evolution of recent years, it appears that Portugal recorded 161 fatal occupational accidents in 2018 (44 in construction), 121 in 2019 (37 in construction) and the same number in 2020 (39 in construction) [33].

The construction industry is regarded to be a dangerous industry. However, it plays an important role in satisfying human development needs. The construction industry accident fatality rate is doubled compared to all other sector averages – 19.5% of all deaths from the period considered were from the area of the construction industry in the EU [34].

The Portuguese office of strategy and studies and the national institute of statistic have defined the following terms :

a) Work accident: Accident at work includes unforeseen events which may kill or injure the worker physically or psychologically, such as a fall, loss of control of a machine, fire, or explosion in the course of work. Any unexpected and unforeseen event, including acts of violence arising out of or in connection with work, which results in bodily injury, illness, or death of one or more workers. Travel, transport, or traffic accidents, in which workers are injured and which occur because of, or in the course of, work, i.e., when they are engaged in an economic activity, or are working, or carrying out tasks for the employer, are also considered as occupational accidents [35].

b) Mortal work accident: An accident resulting in the death of the victim within one year after the day of its occurrence [36].

The following figure shows a graph of a study done by the studies and strategy office in Portugal of mortal accidents occurred in the construction sector:

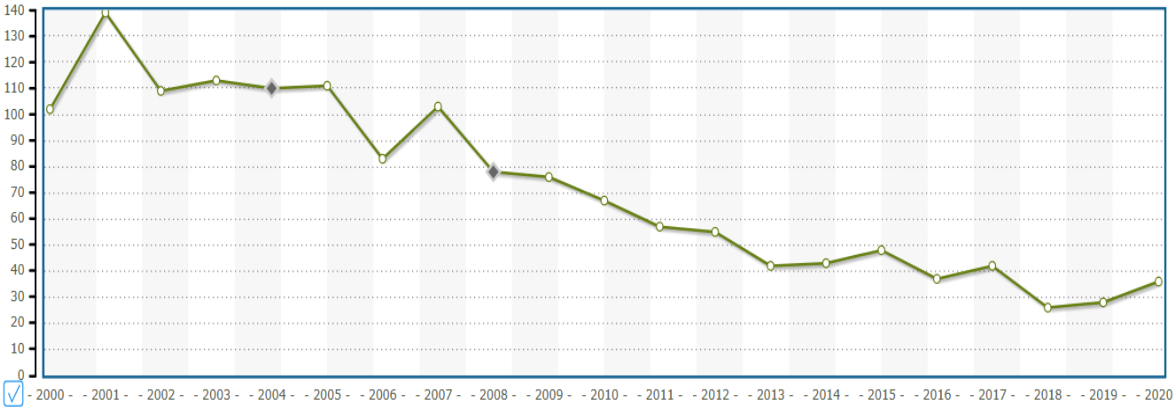

Figure 4.1 - Mortal work accidents (Construction) [36]

Another indicator of the importance of following the security work plan is the mortal accidents as fall down, crushing and chocks or another type of accidents showed in the following Table 4.1.

Even with the development of companies' strategies and safety plans numbers of death cases were getting higher for the past twenty years. Could be related to the fact of the very wide-spreading large-scale projects nationally and the recently revived activity of rehabilitation and maintenance projects which they could cause high probability of accidents occurrence.

Table 4.1 - Mortal work accidents by economic activity (Construction) [37]

Years	Economic Activity Sector
	Secondary
	Construction
2000	102
2001	139
2002	140
2003	141
2004	142
2005	143
2006	144
2007	145
2008	146
2009	147
2010	148
2011	149
2012	150
2013	151
2014	152
2015	153
2016	154
2017	155
2018	156
2019	157
2020	158

4.1.1 The framework of health and safety in rehabilitation and maintenance of buildings with condominium management

Over the years, buildings need rehabilitation and maintenance works. With the entry into force of Decree-Law No. 155/95 of July 1st, which transposed Community Directive 92/57 / EEC, of the Council of June 24th, into national law, currently revoked by Decree-Law no. 273/2003 of October 29th 2003, which revises the Regulations on safety and health conditions at work in temporary or mobile construction sites, new actors and new responsibilities have emerged in terms of health, safety and hygiene at work (H.S.H.W).

It's common for condo management to be unaware of their obligations regarding safety. The Project Safety Coordinator is required to create a "Technical Compilation" in accordance with Decree-Law No. 273/2003. Under the supervision of the site manager, the work Safety Coordinator is accountable for the work's progress up until the deadline for sending the completed project to the work owner. The Technical Compilation serves as a file that gives

information about the health and safety concerns that should be taken into account during maintenance, repair, or future construction projects to the Project Owner or other parties who may be in charge of the project in the future. This document needs to be generated throughout the construction phase, prepared during the design phase, updated as needed, and applied during the construction activity [38].

As shown in figure 4.1, anytime there is a forecast of intervention by two or more businesses, the condominium management will be required to establish a safety coordinator.

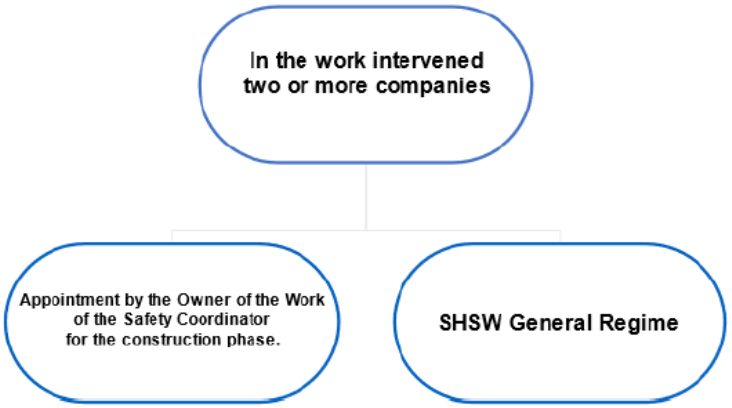

Figure 4.2 - Appointment of the safety coordinator at the construction stage [39]

As a result of Cristina Reis's study [40], and her developed mathematical model, one can analyse the results obtained from the analysis of 709 work accidents in the construction sector in Portugal from 2000 to 2002, through the analysis of work accident inquiries from the country's Authority for Working Conditions.

One of the investigations to be done, whenever there is an accident, is whether the work in question had the safety and health plan implemented or not. If so, analyse whether its content referred to the work in question [40]. From the examination of table 4-2, it was revealed that, in most situations, there is no Health and Safety Plan in place, representing a total of 60.4% of accidents. Combining the unknown scenarios in which the elements under examination are omitted, this almost definitely suggests that such a document did not exist. As a result, approximately 66.6% of incidents occur in workplaces without a Health and Safety Plan. It should also be highlighted that accidents occur in 33.4% of workplaces where there is a Health and Safety Plan. However, this guideline was never applied in 8.5% of these works. Only 16.9% of the works were properly prepared and implemented, with 8% referring to the work in issue as a mere adaption to comply with the applicable legislation. Because it is important that it exists, adapts to the task, and is implemented, it can be called a good and fundamental project in safety management [38].

Table 4.2 - Accident distribution according to the existence of the health and safety plan [41]

Variable		N	%
Safety plan	Unknown	44	6,2
	Exists	120	16,9
	Exists, but it was not fulfilled	60	8,5
	Exists, but it doesn't fit the work	57	8
	It does not exist	428	60,4
	Total	709	100

Construction site manager is most essentials interest areas is his labour workforce safety, raising safety awareness is an asset and construction activities always should be supervised. Safety awareness is the first concern in the construction process, and every staff member is needed to keep it in mind [42]. The main cause of material stacking, and space planning troubles is a lack of safety awareness, which has a direct impact on the project construction process. Some workers on construction sites frequently do not wear safety helmets while working, or the fire protection routes on the site are obstructed, threatening the safety of the construction site. The project's relevant person in charge shall swiftly develop a normative system, neatly arrange construction materials, park various machines and equipment in line with regulations, arrange employees to conduct regular inspections, and so on. Ensure that building sites are adequately safe, as well as limit the potential for safety hazards through diverse management strategies [43].

4.1.2 Use of BIM tools for construction site's organisation

The building site and its elements produce conditions that encourage the emergence of dangers to worker safety during work execution. The analysis shows that these elements are significant in the collection of characteristics that describe the causes of accidents in the construction industry. Construction is still one of the most dangerous sectors in Poland. Safety standards and adherence to Occupational Safety and Health (OSH) regulations continue to fall short. To modify this image and reduce the causes of accidents, long-term operations are required to first change the mentality, awareness, attitude, and behaviors of construction participants. Unfortunately, this method, in which everyone worked individually and passed the results on to the next person in the process, has a few downsides. This type of method is based on serial work, which may produce disruptions in the flow of information to individual recipients, such as a lack of current updates of architectural foundations provided to constructors and installers, most imprtantly to the site manager [44]–[46].

A guideline for planning work safety is essential. At present, everyone involved in the construction process should appreciate the importance of occupational safety on the construction site. Individual goals should be recognized and marked in terms of security level, quality, and a defined hierarchical framework of personnel responsible for construction tasks. All employees should be aware of their responsibilities and their obligation to promote workplace safety. The investor should be notified about the security requirements that must be maintained when constructing architectural and construction solutions, as well as designing specific building works and technical systems, early in the investment stages [44].

The following goals should be implemented by the BIM software:

- BIM-based safety planning - layout and location of individual security measures, altitudes and distances of barriers, fences and support of planning works involving specific hazards and security risks, e.g., earthworks or works at heights,
- 3D visualization in the scope of security - the use of a separate layer or layers of the model for security visualization, the selection of secure communication routes at each stage of the construction project implementation and information and warnings about current threats in the performance of individual technological processes,
- Risk analysis and assessment of designed solutions and technologies - BIM software should enable risk assessment and be used to analyse technological solutions, and in more advanced systems of automatic evaluation, risk assessment and identification.

There are some software packages and programs in the market with an established reputation widely used by designers and site managers that help the possibility of implementing security issues in the project's structure.

Selected programs included:

- Tekla Construction Management system, producer: Tekla

  This system has no modelling tools. The package manufacturer focused here on tools in the field of planning, organizing and time management. The program performs the tasks of visualizing projects, plans, and schedules, and also enables planning in the field of work safety. It is possible to combine and copy, duplicate, and transfer both temporary protection elements as well as take into account and operate data provided by the designer in the scope of construction elements.

Comparing the capabilities of the software, in the scope of the module, scheduled with available MS Project or Oracle Primavera packages, a serious limitation is already visible at the initial analysis - the shortest unit of time in which the project is carried out is one day. This restriction causes disqualification of this software in specialist technological processes at the construction site.

- Tekla Structures software, produced by: Tekla

  An extensive software package containing tools for modelling concrete structures, modelling steel structures, and a library of prefabricated elements. It enables modelling corresponding to individual construction phases to which custom elements and components for work safety planning on the construction site can be applied. The software makes it easy to import existing models in IFC4 and DWG5 formats and has developed export possibilities and adaptations of the final project in IFC format.

Choosing software to implement a job security system and assessing occupational risk in individual stages of the construction process is not easy. Successful completion of the task using the above project participants. From the beginning of the project, the fundamental principle should be the integration and cooperation of all participants.

When creating the 3D model (Fig. 4.2, 4.3) with the layers of safety modelling and occupational risk, it is critical to maintaining as much alignment as possible with the flat system designs (layout, colours, and symbols).

Figure 4.3 - Comparing model and live situation: Safety railing detail in the corner of the slab [47]

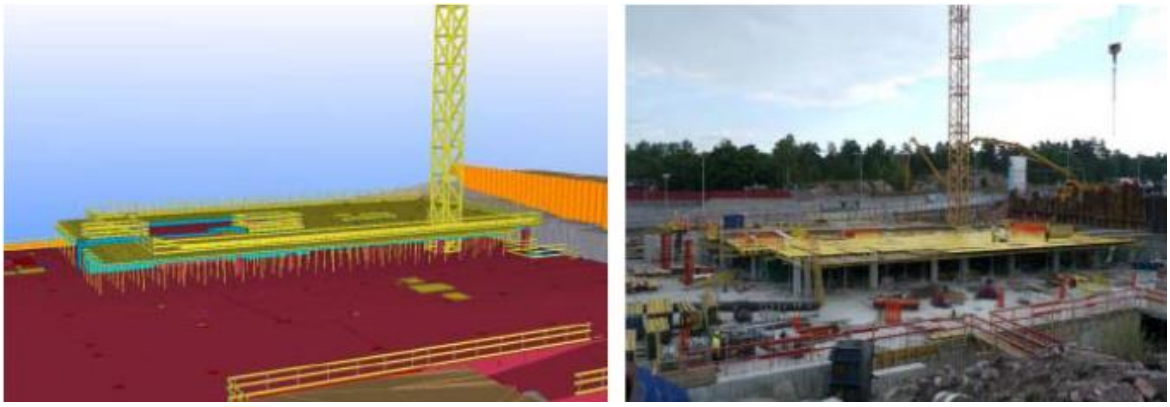

Figure 4.4 - Comparing model and live situation: A general view to the construction phase [47]

4.1.3 Construction site safety management based on Structural Equation Model (SEM)

The construction project provides a huge number of employment prospects for site personnel, and the health of construction workers is closely linked to the construction site's safety management. A measurement scale for the construction worker's health and construction site management was designed using of literature analysis and group interview. After that, through the Structural Equation Model (SEM), results shows the path between the construction worker's health and construction site safety management of the labours and contractors. Important to mention that construction worker's physical health and the safety technology management are the core of construction site safety management [48]. on which relies on the site manager, therefore as a leader, the construction managers are responsible for making sure that their employees are informed about safety risks, have the right protective equipment and are following the right procedures.

Construction technologies are becoming more complex, industrialisation is increasing, and safety management methods on construction sites are being updated on a regular basis. However, there are frequent safety mishaps caused by construction employees' lack of education and awareness [49]. As a result, construction site safety management and worker health are key concerns in civil engineering.

A study made by Ying Huang, Jinguo Wei, Mengru Liu and Wenwen Xiong in Xi'an University of Architecture and Technology (XAUAT), Xi'an, Shaanxi, China laborers work under the supervision of the contractor's project manager to provide construction site safety amenities. The psychological activities and personal behaviour of construction workers have a significant impact on the strength of safety measures and the degree of wear over time. At

the same time, construction workers are the primary target of construction site safety measures [48]. Eight related hypotheses were proposed, survey and data collection from 298 valid answers obtained with a set of variables. Using the Structural equation model (SEM) which is a typical method to study the relationship between potential factors.

Table 4.3 - Variables and their reliability and validity tests [48]

Dimension	Element variable	Measurement items	Cronbach's α	KMO
Construction workers' health	Construction workers' mental health	Construction workers' bad ideology Construction workers' bad mentality Construction workers overworked Poor interpersonal relationships among construction workers	0.79	0.83
	Construction workers' physical health	Construction workers' site physical examination Bad dormitory environment for construction workers Cleaning and disinfection of workers' living areas Cleaning and sanitation of workers' canteens	0.78	
	Working environmental health	Environmental temperature in construction operations Environmental humidity in construction operations Construction lighting at night Use of construction protective equipment	0.64	
Construction site safety management	Safety system management	Safety management production responsibility system Safety education training system Safety management process inspection system Safety management rework system.	0.78	0.83
	Safety agency management	Institutional setup Safety Risk Manager Qualification Safety contingency plans Closed management	0.72	
	Safety technology management	Construction equipment External lift Foundation pit support Formwork engineering Institutional setup	0.78	

Where KMO is the reliability measurement index of the scale, and Cronbach's α is the measurement index of internal consistency of the scale.

According to the study findings, the beneficial effect of construction workers' health on-site safety management is primarily evident in technology management, with physical health of construction workers having the most significant positive influence on on-site safety management. The positive effect of construction site safety management on construction employees' health is most seen in their mental and physical health, with safety technology management having the most substantial positive effect on their health. As a result, the contractor should pay more attention to the physical health of construction employees and the use of safety technology management [48].

4.2 Effective strategy and practice of construction site management

In comparison to the overall project, the construction site of a construction project is comparable to a large-scale production workshop of a manufacturing-type firm, and it is critical to creating value and profit for the entire project. The construction project involves several industries and is linked to the country's rapid economic development. As a result, it requires special consideration. Many concerns, such as the environment and management's people, must be addressed at the construction site management, affecting the overall project's safety. People's standard of living has gradually improved as the economic situation has improved. The community's demand for building products is growing in tandem with the rapid expansion of the modern construction industry. The building business faces both an opportunity and a challenge [50]. To fulfil the development needs of modern industries, the relevant person in charge of construction projects which is the construction site manager must raise investment in the entire design and management process and enhance management efforts. The management order for the on-site construction environment and other components of the construction project are directly tied to the overall project's quality and value, affecting the project's subsequent use, and it requires attention and increased efforts to enhance [43].

4.2.1 Site management overview

On-site management involves the use of scientific methods and evaluation criteria to carry out comprehensive and reasonable planning and organization work on various production

factors (manpower, machinery, materials, etc.) involved in the production site environment, as well as to improve coordination and detection work to ensure the overall operation of the site to maintain stable development, in order to achieve high-quality, high-efficiency production purposes [51].

First and most importantly, on-site management is key in supplying critical information. If only certain indirect data is taken into account for project operations, the findings may be inaccurate and insufficiently operable. Second, the setting can accurately depict the people's working situations and ideological trends. Human resource management is critical to the growth of any industry [52]. As a result, the process of observing and administering the site can actually reveal the employee's performance in his or her position as well as represent his or her attitude toward the job material. The setting and completion of on-site management objectives on time is a crucial component of the company's operation. This situation is even more significant to the growth of the construction industry. The construction project of the construction industry shall supervise and manage the varied on-site construction conditions, continuously optimize the management measures, and effects, and carry out various activities in a planned manner so that the project is completed on a regular basis by quality [53].

4.2.2 Problems in construction site management

4.2.2.1 Personnel issues

At the moment, there is a relatively strong need for technical talents in the construction sector, owing to the fact that management-oriented talents in the technology industry are in short supply and brain drain is common. Many construction site managers are young and have limited expertise in technology management. As a result, for the construction project, the site management of the project construction must resolve personnel issues. Management staff must deal with a large amount of engineering project management content, such as on-site installation technology, program preparation, technical knowledge, and so on. The number is huge and working at the office takes a long time. It is also vital to monitor construction quality on-site and resolve technical issues. As a result, technical management specialists are critical to construction site management. However, many construction projects lack such talents, and some are biased toward technology while others are prejudiced toward management, resulting in poor on-site management results and trouble achieving full-court control [43].

Lack of technological progress adaption is also an important issue as the construction industry's extraordinarily delayed adoption of new technologies has become the standard. Despite the fact that many business owners understand and recognize the numerous benefits that new technologies can provide, it is still uncommon to see a construction business owner invest in adopting a new technology for their organization. The irony is that many of the new technologies, such as BIM for planning and scheduling, drones for monitoring, VR for training, and so on, may be utilized to solve other construction-related problems at least partially. Furthermore, organizations that embrace newer technologies tend to recruit younger professionals, addressing one of the construction industry's major challenges. The point at which the implementation of some technology is unavoidable for the company to remain competitive is approaching, and early adopters will have a significant advantage over more conservative companies in this regard.

4.2.2.2 Equipment issues

There are several types and amounts of construction equipment, which means that one of the focuses on project site construction management is equipment management. To begin with, there are numerous issues with the project department's lack of consistency in equipment management. Managers merely need to compare the parameters of the equipment to determine the project's management state. However, many managers frequently simply focus on the length, ignore equipment maintenance, and lack accurate data records. Furthermore, a variety of idled items are placed in some sealed devices, resulting in a large number of devices that lack people control and are underused. Furthermore, there are certain issues with equipment management work on the construction site. Many projects for on-site construction equipment have not received attention, and it is difficult to fundamentally improve the performance of site management. The management of numerous pieces of equipment has not established a standardized method and has been ineffective in terms of cost control [43].

Mistakes may also occur during the detailed design process. Consider a circumstance in which communication between the designer and the assistant is strained. While working on the specifics, the designer switches to another device. This information does not reach the assistant for some reason, or the site manager ignores it for some reason, and a design problem happens. A somewhat different, but equally unpleasant and costly issue happens when, after the conclusion of works, it is discovered that, due to alterations made during the building of the entire project, the gadgets ordered do not fit into it for some reason. The entire investment will thus fail to fulfil its purpose.

This issue could lead us to another problem where all mistakes could be started from, which is described in the next paragraph.

4.2.2.3 Lacklustre of communication

Communication is a crucial skill in any career, but it is more important when work is outsourced among several people. Without clear and effective communication, key tasks might fall through the cracks, and the team may be unaware of an issue until it's too late to fix it. As a result, project managers must establish firm guidelines. It's not unusual for a lack of communication to lead to the failure of a project. Communication across departments is difficult enough, but construction managers must go above and above since feedback and project status are crucial to them. At the conclusion of each day, there should be communication up a clear ladder informing the team of any progress or challenges. This allows for proactive issue-solving. If in-person meetings are not a possibility, adopting various forms of software might be an effective answer. To minimize this potentially devastating issue for construction, managers must concentrate on establishing adequate communication channels with various departments in order to avoid falling behind on project completion, among other things.

4.2.2.4 Problems with construction materials and tools

Firstly, there is a manpower scarcity in building material management, and the situation is unstable. There is sometimes more than one individual. This disorganized administration has resulted in a lack of systematic material management at the site. Some managers and gatekeepers did not handle the material in terms of identification and upkeep throughout the actual building activity. Furthermore, some materials may be damaged to varying degrees when they are received and delivered. When some vehicles arrive at the building site, there may be delays in loading and unloading. Different forms of damage elements will raise the cost of materials in transportation as well as the overall project's operational costs. Some persons ignored the necessary laws and did not properly manage the precise amount of materials throughout the process of taking over the materials, which resulted in an increase in the cost of material inventory and made it difficult to fully demonstrate its involvement in the building process. (Table 4.4) shows issues with the storage of materials and articles on building sites [43].

Table 4.4 - Construction site problems [43]

Issue number	On-site problems	Frequency of occurrence	Reason
1	Random raw materials stacked	often	Missing management rules
2	Stacking construction waste	often	Missing management rules
3	security risks	often	Lack of safety awareness
4	Project drawings and documents placed in confusion	usually	Lack of management regulations
5	On-site management confusion	often	Unknown management system
6	Equipment parked at random	often	Management is not implemented properly
7	Daily litter is littered	usually	Management is not standardized
8	Staff don't wear safety helmets	often	Lack of safety awareness

4.2.3 Improvement strategy

4.2.3.1 Regulate on-site items finishing

The building industry is becoming increasingly competitive. To distinguish oneself from the crowd, it is vital to display good uniformity in all aspects to ensure that construction projects are completed on time and with high quality. A good working environment should be created during the on-site management process, and on-site technical and managerial personnel and workers should be strictly required to establish a perfect supervision mechanism, with special staff arranged to examine and record the actual implementation of the various systems. The site manager will most likely clarify these activities before the commencement of the execution. If the finishing task at the scene is not completed, the build-up of cluttered things will have major consequences and will disrupt the work process. For some products, for example, they can be split into emergency zones and emergency areas. Tools that must be utilized during the building phase, such as cutting machines, tiny carts, and steel rulers, are mostly piled in the emergency areas [43].

4.2.3.2 Perfect planning

Make reasonable plans for the construction project's construction site environment and improve the site layout. The overall planning of the current project situation is divided into distinct regions and marked by isolation. For example, special placement areas for construction materials, construction equipment, and machinery should be established to avoid the problem of stacking disorder on the site and to create a clean and tidy atmosphere on the site, ensuring that the on-site roads are sufficiently smooth, thereby improving the efficiency of on-site construction. Shorten labour hours while maintaining quality. Figure X illustrates the precisely planned material. The office area, material area, mechanical equipment area, construction area, and housing area may all be put up on-site, allowing for stacking and disposal while also logically planning the site space. Materials should be neatly stacked in the area where they are stored, and different materials can be used to isolate them with eye-catching colours. Kanban can be used to specify the item's name. The division of material regions can be segregated according to the different building themes for different stages of construction. The major body of civil engineering and steel structural materials, for example, should be stacked separately.

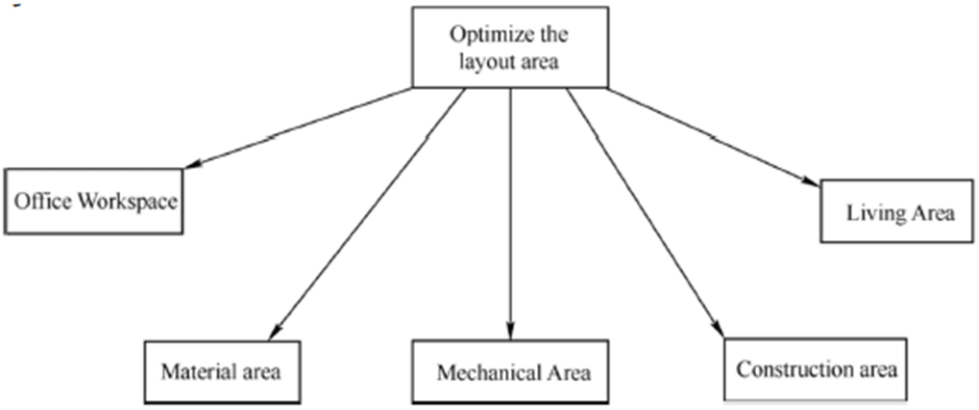

Figure 4.5 - Planning layout [43]

4.2.3.3 Strengthen quality control

Because of all the contractors and teams, not every project satisfies code standards. Many qualities assurance and quality control techniques slip between the cracks in the absence of well-defined management systems or policies. The superintendent is accountable for the quality of work, and they are frequently overworked. Quality and standards may vary from job to job due to changes in staff and suppliers. Because the entire supervisory process is informal, quality management is difficult to oversee. Switching to a more structured management method improves construction site quality while decreasing the amount of time and money spent on rework. Creating and implementing a structured process is the

best strategy to improve construction quality management. It may appear that there is a lot to deal with, but developing a process is only a few of steps [54]:

1) Set Quality Standards;
2) Set Educational Training;
3) Measuring Construction Quality Management Processes.

Quality is the number one objective in the creation of construction projects. As a result, monitoring quality issues is critical in order to strengthen construction site management. First and foremost, during the building preparation stage, the adjustment of the appearance data of the construction entity should be completed on time. For the control of mandatory documents, the site manager must make a formal written statement describing the difficulties that exist on the construction unit and specifying the related responsibilities. Furthermore, the civil engineering element of the construction should increase process quality control, modify methods, and assure construction quality. Improve the monitoring system for building materials to guarantee that the materials will not be destroyed during the procurement process to access the site and verify the level of each level to check the quality of construction materials so that subsequent usage is not hampered. Improve management strategies, establish comprehensive quality management methods, and increase the effectiveness of quality oversight.

The construction project takes a long time, a wide range and variety of professional technologies. It is crucial to increase all-around management and control in order to maintain the safety of the construction site, thereby ensuring the construction duration and working quality, and ultimately occupying an important place in the harsh market rivalry.

4.3 The leadership practices of construction site managers and their influence on occupational safety

In 2020, the construction industry accounted for more than 20% of all recorded occupational accidents in Europe. Leadership is a necessary prerequisite for workplace safety. Transformational leadership is regarded as a key component of safety-promoting leadership, whereas passive/avoidant leadership is regarded as a key component of poor safety leadership.

Transformational leaders are those who elevate their followers' ambitions for achievement and self-improvement while simultaneously encouraging the growth of groups and organizations. Instead of responding to followers' immediate self-interest with a carrot or a stick, transformational leaders arouse in the individual heightened awareness to key issues, the group, and the organization, while increasing followers' confidence and gradually shifting them from concerns for survival to concerns for achievement, growth, and development [55], [56]. Idealised influence (charisma), individualised consideration, intellectual stimulation, and inspirational motivation are all characteristics of such leaders. These elements represent the four fundamental components, or "Is," of transformational leadership [57].

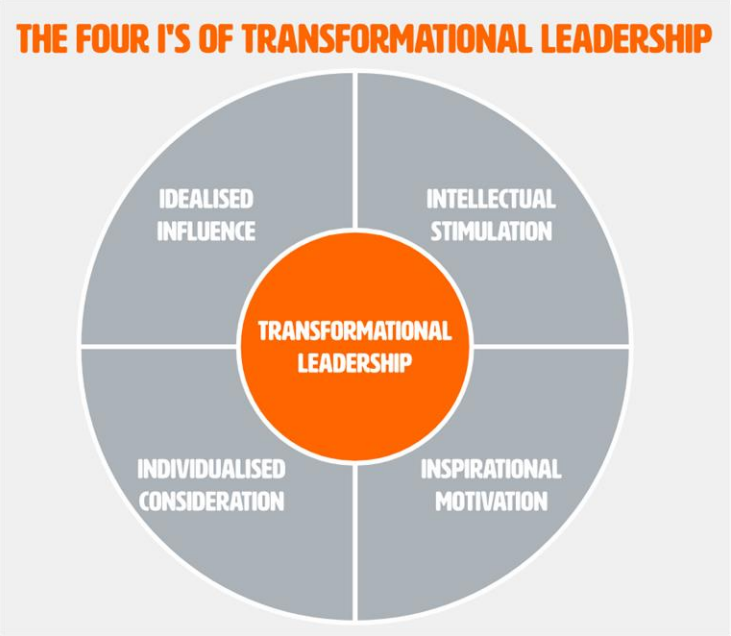

Figure 4.6 - The four elements of transformational leadership [58]

The construction business is one of the economic sectors most impacted by occupational injuries, particularly severe and fatal ones. Construction accounted for more than 20% of the 3331 European occupational fatalities in 2020 [59] A recent occupational safety study indicates that how leadership is implemented may be critical for how workplace risks are controlled, and occupational safety is advanced throughout economic sectors [60]. Transformational leadership has been identified as an effective safety leadership component. Transformational leadership entails customized consideration, intellectual stimulation, inspirational motivation, and idealized influence; it is understood to engage employees without using authority and to stress growing managers' and employees' common interests. In contrast, passive/avoidant leadership has been highlighted as a component of poor safety leadership [61]–[64]. Although transformational and

passive/avoidant leadership styles have been found to be influential for occupational safety, contingency leadership theory and situational leadership studies reveal that the constituents and effects of leadership practices are contextually dependent [65], [66]. What exactly constitutes transformational and passive/avoidant leadership differs, for example, among occupational sectors and hierarchical positions [67], [68]. Context-specific knowledge about how managers in the construction sector practice transformational and passive/avoidant leadership can lead to a greater understanding of how current results in leadership research can be used in real-life managerial activity. Furthermore, management leadership practice appears to vary according to the national cultural context [69].

In the construction business, construction site managers play critical duties. These managers hold a middle management role that requires coordination of many interacting employees, subcontractors, and external entities across organizational boundaries. On a daily basis, construction site managers exercise leadership at both the operational and strategic levels. The central performance variables of site managers were more closely associated with site managers' personal leadership abilities than to project characteristics such as building type, complexity/size, and project duration [70]. Furthermore, research has indicated that construction site managers' transformational leadership methods appear to be significant for construction site safety performance in terms of occupational injuries and safety-related work behaviour among employees and the safety climate on building sites. Furthermore, construction site managers' passive/avoidant leadership practices appear to be negative to the construction site safety climate. Employees' global ratings of perceived leadership behaviours acquired through questionnaires are used to classify leadership behaviours as transformational or passive/avoidant. It has been stated that transformational leadership research needs to go back to the drawing board in order to develop consistent behavioural leadership theories and reconnect with real-life management leadership practices [71].

4.3.1 Leadership and safety performance

In population-based register studies, safety is generally defined as the absence of injuries. However, because injuries are relatively rare, they are subject to stochastic effects in observational empirical investigations, which often do not allow for such huge study materials. injuries as the outcome variable is sensitive to stochastic effects. Injuries are also lagging signs of safety [72].

The most important feature of safety climate and the biggest predictor of safety outcomes has been identified as management safety priority, commitment, and competence [73], [74].

4.3.2 National culture as precursor to transformational leadership behaviour

Believing that observed transformational leadership behaviour among construction site managers in some European nations is positively linked with construction site safety, and passive/avoidant leadership is negatively associated with safety, evaluating potential antecedents to such transformational and passive/avoidant leadership is highly merited.

Favourable national cultural conditions have been recognized as a significant antecedent of leadership behaviours [69], [75]. Mr Dorfman [75], argue that cultural leadership standards stimulate site managers to develop certain leadership practices within certain national entities, Dr Grill [76], suggests that certain managerial leadership behaviours are more acceptable, recognized, and acknowledged by senior managers and junior employees in particular cultural situations than in others.

Managerial safety leadership in Sweden was described as more proactive, participative, and transformative than managerial safety leadership in Denmark in interview research [77] with managers and workers in the Scandinavian construction industry.

Previous studies on the role of transformational leadership for construction site safety have relied on employee ratings of leadership behaviours, mostly using common source data on safety performance [63], [78].

A recent observational study in 2019 [79], made by a group of researchers: Martin Grill, Kent Nielsen, Regine Grytnes, Anders Pousette & Marianne Törner. from the University of Gothenburg, Sweden. The aim of the study is to assess the importance of transformational and passive/avoidant leadership for occupational safety with combined method design, adding third party observations of construction site managers' behaviours, with questionnaire responses from construction employees. Three hypotheses were implemented as a base to the study [79]:

1. Hypothesis 1: observed transformational leadership is positively associated with employees' ratings of construction site safety, in terms of

a) management safety priority, commitment, and competence and;

b) employees' safety-related work behaviour.

2. Hypothesis 2: observed passive/avoidant leadership is negatively associated with employees' ratings of construction site safety, in terms of
    a) management safety priority, commitment, and competence and;
    b) employees' safety-related work behaviour.
3. Hypothesis 3: observed transformational leadership is more frequent among Swedish than Danish construction site managers.

A regression model examining the effect of national context was estimated to examine the differences in the amounts of observed transformational leadership behaviours at Swedish and Danish construction sites (hypothesis 3). Considering the managers' age, managerial experience, time at the site, company size, and employees' ratings of management safety priority, dedication and competence, safety-related work behaviour, age, and employment status, regression coefficients were estimated.

As result of the study there were 297 interactions recorded, and 432 distinct leadership behaviours were identified, defined, and analysed. The observed quantities and proportions of leadership behaviour among construction site managers are shown in Table 4.5 below:

Table 4.5 - Quantities (Q) and proportions (P) of observed leadership behaviours [79]

	All managers		**Swedish managers**		**Danish managers**	
	Q	**P**	**Q**	**P**	**Q**	**P**
Transformational leadership	77	0,18	55	0,24	22	0,11
Idealized influence	5	0,01	5	0,02	0	0
Inspirational motivation	8	0,02	6	0,03	2	0,01
Individualized consideration	14	0,03	12	0,05	2	0,01
Intellectual stimulation	50	0,12	32	0,14	18	0,09
Passive/avoidant leadership	70	0,16	35	0,15	35	0,17
Passive management-by-exception	47	0,11	21	0,09	26	0,13
Laissez-faire	23	0,05	14	0,06	9	0,05
Active transactional leadership	285	0,66	140	0,61	145	0,72
Contingent reward	166	0,38	81	0,35	85	0,42
Active management-by-exception	119	0,28	59	0,26	60	0,3
All behaviours	432	1	230	1	202	1

Transformational leadership accounted for 18% of all observed leadership behaviours. Intellectual stimulation was the most common transformational behaviour, accounting for about two-thirds of all such behaviour, whereas individualized consideration, inspirational motivation, and idealized influence were the three most infrequent leadership behaviours overall. While passive/avoidant leadership behaviour accounted for slightly more than 16% of all observations. Passive management by exception was observed twice as frequently as laissez-faire leadership [79].

National culture was an antecedent to transformational leadership behaviour as it was found to be more common among the Swedish than the Danish construction managers.

Laissez-Faire Leadership is defined as the “absence” of leadership and avoidance of intervention. Leaders that utilise this leadership style delay making decisions, do not provide feedback, and do not reward their employees for good performance; in fact, little to no effort is made to motivate people or recognise their work at all [80].

The site managers' laissez-faire leadership behaviours included explicitly noting problems or tasks that needed to be addressed but not taking action. Instead of confronting non-compliant employees directly, managers chatted with others behind the worker's backs. Managers could even make jokes about unsafe work conditions, such as a carpenter who failed to wear ear protection when required. The site managers exhibited laissez-faire leadership when they were contacted by others for information or directions but did not provide the desired information. The site managers lacked the relevant information and made no effort to obtain it during these discussions. Laissez-faire leadership behaviours were also observed in circumstances where someone else was present, such as the safety coordinator, another site manager, or a higher manager. Site managers displayed laissez-faire behaviour in these scenarios by being inactive, for example, during safety meetings held by the safety coordinator. During such meetings, site managers also demonstrated more active laissez-faire behaviours, such as criticizing safety manager suggestions or blocking a fire instructor's agenda [79].

These results suggest that in order to improve safety performance, the bulk of leadership behaviours, i.e., active transactional leadership, should be combined with a high degree of transformational behaviour and a low degree of passive/avoidant behaviour [79].

4.4 Stress among site managers

Understanding the nature of workplace stress is far from comprehensive. However, research findings consistently support the assumption that occupational stressors and specific personality characteristics may be predictive of stress manifestations such as mental illness, coronary heart disease, job discontent, and accident participation. Stress is not intrinsically harmful; it stimulates and challenges us, and it is the spice of life, necessary for growth, development, and transformation. Mismanaged stress creates "distress" when there is an imbalance between demand and supply. Some employees in complex industrial organisations are subjected to increasingly stressful situations, to the point that their physical and psychological health suffers. The consequences of stress on both individuals and companies are staggering [81].

The mental and physical effects of stress can also have a significant impact on family life [82]. Costs may include divorce, conflict, and/or frustration. These elements, in and of themselves, may worsen the sense of stress in the workplace. Stressful home issues flow over into the office, having a negative impact on both the individual and the firm (see Fig. 4.7). Thus, while examining stress sources, it is critical to take a comprehensive approach, and the home-work interface must be considered [83], [84]. While it is not always possible or desirable to eliminate stress from the job, it can often be avoided or optimised. Thus, it is vital to be aware of the potential stressors that exist before a course of action can be taken.

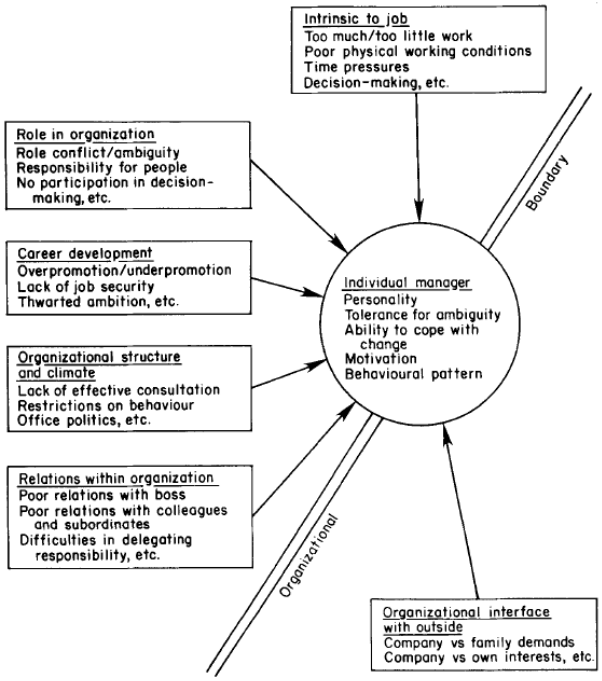

Figure 4.7 - Sources of Managerial Stress [85].

(Fig. 4.7) also highlights that it is important to consider individual differences in response to stress.

A pilot preliminary study investigating stress among construction site managers in a large UK construction organization done by Valerie Sutherland, PhD, Visiting Lecturer and Marilyn J. Davidson, PhD, Senior Lecturer in organisational psychology at the University of Manchester Institute of Science and Technology, UK [81]. In-depth interviews and standardised psychosocial questionnaires are used. The study included 36 male middle and senior construction site managers. The managers identified communication issues, work overload, conflict, and insufficient time spent with family as important sources of stress. The findings stated that job satisfaction was lower than in comparable managerial groups, and the majority of dissatisfaction was connected to employee relations concerns.

The main goal of this investigation was to analyse and identify potential sources of stress among site managers, hence the interview technique was used amongst site managers (all males) . The second goal was to utilise standardised questionnaires to assess two "symptoms" or "outcomes" of stress exposure [81]. Individuals are also asked:

a) Their biggest source of stress,
b) How stress could be minimized and,
c) Whether there was a need for stress management programmes.

Table 4.6 collates the 10 most frequently mentioned sources of stress among all the construction site management. While there were a few "top 10" stressors in which appeared to be site-sized related, the major stressors isolated by all managers concerned communication issues, too much paperwork, work overload and time pressure. Lack of competent staff problems were the next most commonly mentioned stressors followed by conflict due to boundary situations, having to work long hours, restrictions concerning time spent with family and at home, and lastly, pressures associated with the dynamic/competitive company strategy [81].

The majority of these stressors would be characterised as "intrinsic to the job". Overall, the most often mentioned source of stress was task clarity, namely inadequacy and irregularity of communication flow. One manager, for example, complained:

> *"People just don't tell me the full story - I was negotiating with a contractor who is already on site, but is no good, and no one had told me."*

Table 4.6 - The 10 most frequently cited sources of stress amongst construction managers [81]

		Percentage of total managers (N = 36)
1	Inadequacy/inconsistency of communication flow	75
2	Paperwork - too much, too much unnecessary, high volume of reading material	69
3,5	Workload - constant time pressure	67
3,5	Lack of competent staff to do the job properly	67
5	Inadequate numbers of staff to do the job properly	64
6	Unable to delegate because of staffing problems	53
7	Conflict of boundary situations	50
9	Working long hours	44
9	Insufficient time spent in family/home environment	44
9	The company strategy - competitive/dynamic/ go-getting image, changing staffing problems	44

The asked question *"What can be done to minimize stress?"* was to describe how the managers themselves believe stress can be minimized, and whether there is a need for stress management programmes.

At the most basic level, actions to eliminate or limit certain sources of stress may be implemented as part of an organisational development programme (OD). When interviewees were asked, *"What would you ask for if you were asked, how could you best be enabled to execute our work (more efficiently, or better in any way)?"*, Many managers (53 per cent) asked for more staff or more capable workers; many others requested training-related support (36 per cent). However, it is obvious that some of the identified stressors are inherent in the job and cannot be reduced or eliminated. To avoid the costs of workplace stress, "stress management" or "stress control" programmes must be implemented [81].

5. Case study (sent-out questionnaire)

5.1 Introduction

Construction management is critical to the success of infrastructure improvements and changing industry responsibilities are causing changes in traditional European construction management practises. European agencies have created construction management systems that encourage more collaboration and long-term relationships between the public and private sectors. When the cost and schedule benefits are significant, for example, international organisations are more likely to assign traditional highway functions to the private sector. The agencies collaborated with the private sector to better understand customers' demands by focusing on long-term partnerships. The strategic use of delivery methods that promote life cycle solutions, the use of qualifications and past performance in procurement, and the delegation of traditional highway agency construction management functions to the private sector have all contributed to a more sustainable relationship between the public and private sectors [86].

Construction management is an essential part of any project's success. And for the sake of this work a pilot study (small qualitative analyse) was realised to better understand how a site manager functionalise himself throughout the execution phase of a construction project.

At first, it was decided to do small interviews directly with the site managers who are responsible of an actual occurring construction projects in the city of Covilhã and Coimbra in Portugal. The idea was to go to construction site already chosen by prior personal knowledge or by information obtained from fellow colleagues who are already working in the construction industry. The first trip to the sites was meant to be for sole purpose of taking real-life photos of the projects and try to make a first contact with the person in charge for the on-site activities. A set of total 15 questions were prepared, and smart mobile phone used as a voice recording device to better keep the information registered correctly and be as brief as possible with the site managers. After all, *"Time is money"* and their valuable time cannot be recompensated.

Three construction sites were visited in the city of Covilhã, in a period of 6 weeks and 9 site-visits attempts took action. The reason behind the high number of attempts was basically because of the following:

1. The construction site manager were absent in two of the sites visited because of meeting or some other unknown reasons even though worker at site were asked and they just did not know where they were;
2. The construction manager is too busy to make an interview, even though a very fast self-introduction and explanation was told that it is for a university graduation work. The managers ignored the author and did not want to collaborate;
3. The site manager was present and was observed to be free to talk, but after self-identifying and brief speech of what the interview is all about, he refused to do so claiming he had to go and be at the office for some reason, yet the author asked him if it is possible that questions would be sent by e-mail and if he could answer them at any time he felt convenient, still he refused to collaborate and his exact words were:

"I don't have time for this stuff, I don't do these things"

After all, nine failed attempts and lost time of 6 weeks, the author decided to abandon this method of direct interaction with construction site manager.

Another approach to obtain information was established which is a survey (See Annex - D) created using Google forms platform, sent out by e-mail to civil engineers which all of them are or were in charge for some construction projects. The survey constitutes of 27 questions related to personal identification, academic and professional level, site management profession and how they would believe can be done to solve some repeated technical or psychological issues.

Around 20 managers received the questionnaire e-mail, unfortunately only 9 (7 males and 2 female) returned the survey answered. Five of total nine registered answers were from projects constructed in Portugal by Portuguese construction companies, and others were realised throughout Europe (Netherland, France), and one in Angola – Africa.

The average age of the responders is 34 years where 27 years being the lowest and 47 is the highest, which is professionally good for young managers to assume charge and take big decisions.

5.2 Questionnaire results

For confidentiality reasons names of survey participants will not be shown, only with their name initials when needed.

Results will be exhibited in graphs, tables as the following:

Table 5.1 - Site managers' academic and professional experience

Name Initials	Age	Gender	Area of study	With or without Master degree	Years of study	Years of experience till promoted to site manager
M.A.	28	Male	Civil Engineering - Building course	With	5	2
P.R.	38	Male	Civil construction	Without	5	8
J.M.	27	Male	Structures and Rehabilitation	With	5	1
J.G.	33	Female	Civil Engineering - Structures and Construction	With	5	1
P.M.	33	Male	Civil Engineering - Structures and Construction	With	5	0.5
S.S.	39	Female	Civil Engineering - Structures and Construction	Without	5	5
J.P.	30	Male	Civil Engineering - Structures and Construction	With	8	1
I.S.	47	Male	Civil Engineering	Without	5	7/8
I.K.	30	Male	Civil Engineering	With	5	4

After a simple analysis for the data shown in Table 5.1, most of the engineers (8 participants) have studied for five years, and only five of them have graduated with a master's degree. Important to mention that three CMs had studied their civil engineering course before the Bologna process (5 years with no master's degree – Pre Bologna Degree), but academically it is as equal as to the Bologna degree While engineer J.P. needed 8 years to complete his master's degree.

The author believes and from close relation that reason for J.P. took him longer than the others is that he suspended his studies several times as he was working in his father construction company and took responsibility from the very early years of his studies, being supervised under professional civil engineers. As a result of such a phenomenon J.P. was

assigned as a construction site manager after only one year of professional work, also his master's academic degree could be considered as an advantageous factor. While the 47 years old engineer I.S. and 38 years old P.R. with no master's degree took them 7 to 8 years to be fully charged as construction site managers. Not only in the male section, but also with the female engineers where the academic level difference took place and one of them needed just one year to be site manager where the other female needed 5 years.

The interesting case is the 30 years old male engineer I.K. who studied civil engineering with master's degree and still took a little bit more time of training than the usual (4 years), Well this case shows that sometimes the duration for a graduate engineer to start being fully responsible and assume the position as a site manager is not a scale for someone intelligence or efficiency. Sometimes it is the policy of the company they are working for, or it depends on the volume of the project they are working on.

Table 5.2 - Engineers company, function and type of projects worked on

Name Initials	Construction company responsible for the execution	Function	Tense of function	Public or private project	Type of project
M.A.	Eiffage construction	Construction manager for the construction company	At the present time	Private	New Construction
P.R.	Mendes & Robalo LDA	Construction manager for the construction company	At the present/past time	Private	New Construction, Rehabilitation
J.M.	Floponor S.A	Construction manager for the construction company	In the past	Public/Private	New Construction, Rehabilitation, Demolition
J.G.	Norcep	Construction manager for the construction company	At the present time	Public/Private	New Construction, Rehabilitation
P.M.	Simão & Martins, Construção Civil e Obras Públicas, Lda	Construction manager for the construction company	At the present time	Private	New Construction, Rehabilitation, Demolition
S.S.	EFS - Engenharia, Fiscalização e Serviços, Lda; CMVS - Engenharia, Fiscalização e Serviços, Lda	Fiscalisation director	In the past	Public	New Construction, Rehabilitation, Demolition, Conservation, Maintenance, Infrastructure
J.P.	SETH	Construction manager for the construction company	In the past	Private	New Construction

I.S.	Joao Neves Geraldes Unipessoal	Construction manager for the construction company	At the present time	Public	Infrastructure
I.K.	Mota-Engil	Adjunct site manager for a construction company	At the present time	Public	New Construction

Table 5.3 - Country and knowledge of the engineers

Name Initials	Country	Do you know there are useful software for construction management?	Have you ever used one?	Do you know any regulations that defines the qualifications and abilities of the construction manager?
M.A.	France	Yes	Yes	No
P.R.	Portugal	Yes	Yes	Yes
J.M.	Portugal	Yes	Yes	Yes
J.G.	Portugal	Yes	Yes	No
P.M.	Netherlands	Yes	Yes	No
S.S.	Portugal	Yes	Yes	No
J.P.	Angola	Yes	Yes	Yes
I.S.	Portugal	Yes	Yes	Yes
I.K.	Portugal	Yes	Yes	Yes

Table 5.4 - Programmes and their use by the construction managers

Name Initials	Can you identify the instrument used and what is its used for?
M.A.	Finalcad: software for the management of reserves during or at the end of the construction site, it also makes it possible to ensure an easier means of communication between all the stakeholders and even the client and contractor
P.R.	Project
J.M.	CYPE, PHS, SS CANDY
J.G.	Centralgest - management of subcontractor contracts, measurement records and orders
P.M.	MS Project
S.S.	MS Project, Autocad
I.S.	Word, Excel, Power Point, Project, CCS
I.K.	MS Project, Excel, SAP
J.P.	1- Autocad: Help in the interpretation of the work; it allows measuring and determining coordinates for the implementation of certain works; allows you to design/develop work support pieces such as pile driving guides, walkways, formwork pieces, etc. 2- Project: Allows you to outline a work plan and check whether the work deadlines are being long, as well as improve the performance of the work through a better interconnection of activities. 3- Excel: Essential and essential tool for any work activity; billing control; cost control; activity control; reporting.

After all of engineers claimed knowledge of software and programmes that can be used to help the construction manager to organise, plan, and report during the execution phase they were asked to name them and maybe explain what they are good for. Answers are shown in Table 5.4. Only four who answered positively about any knowledge of any regulations, legislations, or professional requirements in order to be able to exercise the profession of a construction site manager are less likely to commit errors especially with subcontractors and workforce labour on-site.

Table 5.5 - Regulations and codes

Name Initials	Identify the regulations, codes, requirements or any national legislations?
J.M.	Namely the CCP (Public Contracts Code), IMPIC Regulation, contract requirements, inscriptions in the order of engineers, etc.
I.S.	CCP (Public Contracts Code) and regulations of the Order of Engineers
I.K.	CCP (Public Contracts Code)
J.P.	Usually the professional card, and a kind of permit that defines what kind of works a work director is qualified to do. I think that the CCP - Code of Public Contracts talks about these requirements.

To know better how deep the participants are in their field, a question presented to them about any construction projects' examples that they worked on or were responsible of, also how big the project was.

Question : *"Give examples of some works you have directed and indicate their typologies and the global values of the works?"*

Seven out of nine engineers answered as the following:

1. Engineer M.A.: Personally, I was on a big project for 4 years, it is a public facility made up of 3 buildings: a large performance hall that can accommodate 1,200 people - a music school with 30 classes - and a neighbourhood house which contains dense rooms, offices, etc. this project was very interesting technically at the level of the technical lot, electricity, plumbing and heating ventilation.

2. Engineer P.R.: Single-family house - Sertã (€285,000), Single-family house - Granja Park (€350,000) / Single-family house - Évora (€2750,000), Single-family house - Castelo Branco (€390,000), Construction of support structures for pumping stations (€600,000).

3. Engineer J.M.: New construction of a home (€1,000,000), Rehabilitation of the Historic Building (€900.00), Construction of single-family houses (€500,000), Inspection - University residence (€5,000,000), Requalification of the urban area (€1,000,000).

4. Engineer J.G.: Meinedo school centre, Lousada - €1.2 million – rehabilitation, Caíde de Rei school centre, Lousada - €1.3 million - new construction, Rehabilitation of the Real Vinicula/ Casa da Arquitetura - €5 million, Colina cultural and social centre, Braga - €1.5 million - new construction, Parish Centre of Leça da Palmeira - €1.3 million – rehabilitation.

5. Engineer P.M.: Single Family House - Arm Pera (€14M), Single Family House - Arm Pera (€1M), 2 Multifamily Houses - Carvoeiro (€4M), Single-family house - Carvoeiro (€2M).

6. Engineer I.S.: Private houses around (€200K +/- €50K), Residential/commercial buildings costing around (€2M +/-€ 0.5M).

7. Engineer J.P.: New Sacavém water drainage network. In this work I worked as a subcontractor, in the execution of a cofferdam for the construction of a new drainage system for the waters of Sacavém ;Global Value - (I only know the value of my subcontract) (120,000.00 euro). Warehouse for supplies in Vila do Conde. In this work I performed the driving of prefabricated piles for the execution of the foundations of the buildings; Global Value - I don't remember, approx. (100,000.00 euro). Construction of the New Breakwater and Pier at the Port of Cabinda. This work consists of a consortium between SETH and Mota-Engil; Overall Value - (52,000,000.00 euro).

A Civil Engineer is considered to possess the skills and knowledge to combine analytical and synthetic approaches for detecting problems to find and apply reliable, safe, economical, environmentally, and socially acceptable solutions. From this point of view, the Civil Engineer is a producer and decision-maker [87]. While the construction manager is already a civil engineer (In most cases), he/she tend to be more technical and practical and wants to get things done with the less errors possible. The second part of the questionnaire was more about the profession itself and about how construction managers (participants) see it

from their point of view. Different answers and ideologies were observed from responders, and are shown in the following group of tables:

Table 5.6 - Engineers understanding of the construction management profession

Name Initials	Indicate what do you understand relatively to the job exercise?
P.R.	Organizational capacity, Pro-Activity, ability to manage conflicts…
J.M.	Technical capacity, constant study of legislation and the evolution of technology, organization, responsibility and above all to like what you do
J.G.	Stress management, time management, organization
P.M.	Ability to manage people/egos
S.S.	Professionalism
I.S.	Knowledge, effective and organized
J.P.	Good understanding/interpretation of all the elements of the work, this can be achieved with a great prepration prior to the work through a careful reading of the pieces drawn and written. A site manager must have a strong character and be able to withstand stress and constant pressure. But the essential thing is the experience, and for that, for those who are starting the ideal is to move forward without fear and make decisions, whether good or bad, every decision we make and every situation we overcome we gain experience and become more efficient.

Only seven participants have answered while the other two failed to answer such question for any known reason.

Mr Vassilis P. Economopoulos the former president of the ECCE wrote in his notes [87], that the Civil Engineer must perform as a professional within a framework of high moral and ethical standards, with compatible building operations for a modern and viable urban environment, in order to achieve sustainable development and the protection of the natural environment. Also, the Civil Engineer should embrace attitudes such as:

- Creativity and Entrepreneurship;
- Commitment;
- Curiosity;
- Honesty and Integrity;
- Optimism;
- Respect and Tolerance;
- Thoroughness and Self-Discipline.

In parallel, engineers from the survey thought the following:

Table 5.7 - Charachter/personality of a construction manager

Name Initials	In your opinion, what are the characteristics and personality features a construction manager should have?
M.A.	Calm, have a global vision of project, sociable
P.R.	Organized, dynamic, proactive...
J.M.	Organized, responsible and committed.
J.G.	Responsibility, communication, knowledge adapt to different people and environments, proactivity
P.M.	Resiliency
S.S.	Leadership
I.S.	Must be a person who solves the problems that will appear before him
I.K.	Politic and patience
J.P.	A construction director should be serene ; assertive ; well disposed but without giving too much confidence to his workers ; demanding ; strong character and able to cope with stress and constant pressure ; always maintain a professional and straight posture towards his workers even if it is outside of work.

Construction managers will be successful if they can effectively lead their personnel to execute the project appropriately. The construction manager will be able to fulfil their daily job tasks swiftly and efficiently if they have skills such as multitasking ability, timeliness, and good problem-solving capabilities. CMs must be fully aware of the dangers and consequences of these difficulties. Many of these issues are directly related to construction operations, while others are the result of indirect, peripheral activity [88]. Well, in this aspect answers from participant engineers were kind of common problems as Table 5.8 displays:

Table 5.8 - Challenges and problems on-site

Name Initials	What are the difficulties/challenges that could face the construction manager
M.A.	Anticipate the maximum of the subjects under construction. The administrative monitoring and ensure its completion bond
P.R.	Management of subcontractors
J.M.	The constant pressure to keep the work controlled, both in terms of cost and execution time
J.G.	Management of teams/contracts subcontracted with values close to the project goals
P.M.	Hiring teams/ Maintaining prices of awarded budgets (due to rising prices of materials and labour)/ Time management for all tasks at his position
S.S.	Much management required
I.S.	Execution projects poorly not suited to its execution plan and difficulties of the work owners and to know well what they really want
I.K.	Contractual management
J.P.	Personnel management - To be able to expedite good relationships and trust between the various workers creating a good environment among all but always maintaining a high degree of excellence and requirement at work.

As mentioned previously in this work that stress factor can be crucial to the on-site activities specially on psychological level for the construction manager himself or to the labour workforce.

Such a question was put in the questionnaire to go deeper in the mind of a construction manager and try to better understand how they would deal and perform under such circumstances. Table 5.9 shows some several brief, and other thoughtful answers:

Table 5.9 - How to deal with stress and pressure as a construction manager

Name Initials	Stress/Pressure are very critical challenges, yet the solid/instant decision making. How do you deal with such a situation on-site?
M.A.	For stress and pressure, you'll have to stay calm and give more time for each mission. And for decision-making, I regularly ask my superiors which they have more experience than me and if they can help me.
P.R.	Always with professionalism, seriousness and conscious of my abilities.
J.M.	Solving as quickly as possible and not leaving to solve later. The work needs these quick answers to be able to flow and not slip in terms of time. Although these situations impose some stress/pressure, they need to be overcome as quickly as possible. In most cases, the problem is not stress and pressure, but the accumulation of these two factors due to postponed matters.
J.G.	Taking responsibility for the decision knowing that it may not always be the best, but that any decision you make is better than wasting time on indecision.
P.M.	Common sense.
S.S.	With calmness.
I.S.	Calmly and very thoughtfully.
I.K.	Courage and self-confidence, without fear of making mistakes.
J.P.	The best way to face these situations are: 1 - Listen to the problem carefully, and try to understand the whole problem with those who demonstrate it (It is important that the problems of the work be communicated to the work director by the general manager, in order to maintain a hierarchy and order). 2 - Remain calm, even if we are startled, we should not show it to others. 3 - Think and analyze the situation well looking for several alternatives, even if we take some time, if the work stops for 30min or more is not serious, the works will eventually resume with normality. If it is really urgent, and we are not sure how to act, it is always a good idea to ask advice from someone more experienced, such as the general manager, who is on the ground full time and has a lot of wisdom knows how to attack certain problems more easily. If it is a technical problem the best thing is to waste the necessary time and find the best solution.

Long and short answers both demonstrated strong, confident, and thoughtful words, they showed real-life experience in which they have faced during their professional exercise as construction managers.

Another note [87] from Mr Vassilis P. E. on how civil engineers and especially those who are in charge of construction projects serve the public interest and humanity's needs. Presenting analytically "public interest character" in a broad range of Civil Engineering Activities as following indicatively referred:

- Safety and quality of the building constructions;
- Conservation and restoration of the world cultural heritage;
- Anti-earthquake protection;
- Energy efficiency of buildings;
- Sustainable Development of infrastructure;
- Safety of the Dams;
- Quality of the life with adequate water supply;
- Quality of the life with sustainable transport;
- Quality of life and environmental protection with upgraded and innovative sewage and wastewater treatment plants;
- Spatial planning for a sustainable urban environment;
- Water Resources Management;
- Renewable Resources of Energy;
- Road Safety;
- Transportation Plans, Public Transport Infrastructure for Sustainable Cities;
- Developing of Railways and Highways Infrastructure, connecting peoples, enhance the sustainable development;
- Facing the Greenhouse Phenomenon and the CO2 Emissions;
- Public Health with advanced sanitary and social infrastructure.

Also, said: *"These works, and activities demonstrate that our Engineering Profession plays an important and critical role in serving the public interest and improving people's quality of life, and should be recognised and encouraged by Engineering Organizations in our Societies. This should be accomplished at both the national and European levels"* [87].

Such an important topic was presented to the CMs participated in the survey as a final question in order to have ideas and proposals for the purpose of making the construction management profession more efficient and recognised. Table 5.10 shows eight answers.

Table 5.10 - Construction management more recognised and efficient

Name Initials	What do you propose in order to turn this profession more efficient and recognised?
M.A.	I propose to improve the project processing in design phase on the part of controllers and designer. This will avoid many subjects and problems to be solved during construction and will also avoid additional costs for the client.
P.R.	More autonomy and decision-making power.
J.M.	A more consolidated integration between the different project stakeholders named direct contact with project teams and contract managers. Usually, the contact is made through inspection, however, I think there should be greater involvement of the design team in the construction phase, especially if the project has been developed using methods of compatibility of specialities, such as BIM. Errors and incompatibilities that are detected in the design or construction preparation phase, avoid not only a slippage in costs (due to the existence of unforeseen works), but also allow a continuous flow of work, without the need to interrupt them to find solutions to the identified incompatibilities.
J.G.	Regulate the values of salaries, working hours and qualifications to practice the profession.
P.M.	Adjunct Technical Staff.
S.S.	Compensation according to function and responsibility.
I.S.	It would be very helpful to have constructive solutions and standardized Execution Projects.
J.P.	To make it more efficient I think that during the course we would need a subject dedicated solely to the direction of work because there is a very short notion of what management of site activities is.

5.3 Discussion

The analyse of obtained data from nine CMs who answered the questionnaire presented that more than half of them needed more than a year to become a construction manager and to be assigned with medium to high volume projects varied between public and private sector, working for different construction companies around Europe and one who had his master in Portugal but working on project in Angola. Projects' type they worked on were combination of all kinds of projects whether it is a new construction, rehabilitation, demolition, conservation, maintenance, or infrastructure. A great set of experience and skills learning could come out of these projects.

All CMs demonstrated knowledge of some software or programme that could be used to help the function of a construction manager, CM M.A. from France mentioned an interesting one named Finalcad, which is an application that could be used from a smartphone or a tablet available to both iOS and Android users founded in 2012 to solve construction companies' problems with site management yet to improve their operational efficiency through a mobile digital platform. Where other CMs mentioned more common

programmes such as MS Project, Cype, and Centralgest which is a software that was developed in Portugal by a software company, it helps with subcontract management, keep track of material orders, and measurements. On legal levels only four CMs cared enough to express their knowledge in terms of building regulations, European codes, professional requirements. Reportedly the Public Contracts Code – CCP in Portugal is the common answer.

Undoubtedly, organisation, responsibility, management, and knowledge are the agreed concept to define the construction manager's profession. Some CMs talked technical capacity and professionalism. CM J.P. extensively added that such a profession needs good understanding and interpretation on what is happening around yet moving forward with the activities with no fear of making big decisions. A construction manager must be calm, have a global vision of the project and sociable CM M.A. thinks. While CM I.S. argue that he/she should a problem solver. Others organisation, dynamic, proactivity, leadership, and resiliency. Interesting point from CM J.P. that construction manager should not give too much confidence to his worker but with professionalism and be demanding. The meaning is a construction manager should not rely so much on labour workforce on-site and they should be always under supervision.

The discussion of the difficulties and challenges that could face a construction manager is considered reliable and depending on the personality of such a professional. Also, the environment of the project in general and how complex the project is. Of course, there are very global common construction site management issues like cost management, deadlines, and other issues that have been discussed previously int this work. In the other hand, seven of the CMs outlined the subcontracting issue and how to manage them or make sure they finish their tasks on time. While CM I.S was having difficulties with the work owner and what he wants. It is also important to consider individual differences in response to stress. However, in the construction industry there many stressors that could affect the quality of the work execution, mental well-being of managers, and could provoke very serious dangers to a CM body organs like heart diseases and do physiological damages to the brain.

As Table 5.9 shows how CMs in charge of construction projects can deal with their daily stress issues. The most common answer was to be calm as much as possible, no need to rush things and getting things done with no quality. J.P. thinks that the best way to deal with stress is to listen carefully to the problem and not to be loud about it on-site. J.P. and M.A. both had a common idea which is always having to communicate with superiors for the

decision making, they are more capable and experienced. While the others are happy to deal with stress by being courage and have self-confidence, common sense, and not to be afraid of making any mistakes.

Proposals and possible futuristic ideas from CMs in the questionnaire are shown in Table 5.10 in hope to make the construction manager profession more efficient and recognised. CM J.M. suggests that there should be greater involvement of the design team in the construction phase, especially if the project has been developed using methods of compatibility of specialities, such as BIM. A more consolidated integration between the different project stakeholders is needed. This could include direct contact with project teams and contract managers. While CMs J.G and S.S. advised regulating the service salaries to be more compatible with high profile profession's responsibilities. Interesting CM J.P. mentioned a particular idea of integrating the civil engineering study courses with subjects more related to the construction management and its activities. In the other hand CM M.A. argue that improving the profession could start from the designing phase with the integration of the construction manager. Such an act will probably avoid many problems that could occur in the execution phase. Also, could avoid any additional costs to the client.

5.4 Conclusion

In general, CMs participated in the questionnaire showed that their academical background needed a little more practical knowledge on some engineering managerial issues.

Early practical work/experience is very important and vital component to the student who probably will become a civil engineer in the future. Unfortunately, most universities in Portugal do not integrate obligatory internships with the courses' units in the fields of engineering. Also, the academic level of a graduate engineer is crucial for both the engineer himself and the construction company as well as technology knowledge of some management software could facilitate the mission and make the execution process more manageable.

Learning about the legal aspects of constructing buildings in university is critical for students in the field of architecture and engineering. Understanding the legal considerations associated with constructing buildings can help ensure that projects are completed on time and within budget. Further, learning about the legal aspects of construction helps students understand the intricacies of the legal processes and identify

potential risks that could affect the safety and stability of the building. This knowledge can be applied to residential and commercial construction projects and can help ensure that projects are completed per local, regional, and national building codes. In addition, having a thorough understanding of the legal aspects of construction helps students become knowledgeable in the vital regulatory process associated with building safe and secure buildings.

Communication is one of the most important factors in the successful completion of a construction project. The site manager plays a critical role in ensuring effective communication between all parties involved. The site manager's primary responsibility is to facilitate the flow of information between the project owner, engineers, architects, contractors, subcontractors, and other stakeholders. The site manager should ensure that all parties are kept informed about the progress of the project, and any new developments as they arise. They should also be mindful of potential conflicts between parties and work to resolve them quickly, efficiently, and fairly. The site manager should also enable open and transparent communication between all parties. By actively encouraging communication, the site manager can ensure that any issues are identified quickly and addressed promptly, preventing costly delays and project overruns. Overall, effective communication is a crucial part of ensuring a successful construction project. The role of the site manager is paramount in facilitating the open exchange of information between all stakeholders.

A construction manager may be unable to fully trust his workers for various reasons. In some cases, workers may be inexperienced or not properly trained, which could lead to mistakes and problems with the construction project. Additionally, workers may prioritize shortcutting to save time and money, which could create projects that are not up to the expected standards. In some cases, workers may even try to take advantage of their position for personal gain, skipping out on necessary tasks or using materials for inappropriate purposes.

The solution to construction site problems is largely dependent on the personality of the construction manager. A construction manager must be able to problem-solve and come up with creative solutions to complex on-site issues. Additionally, depending on the type of management style that the manager utilizes, the solutions for potential problems may vary between those with command-and-control styles of management, who tend to take a more directive approach to problem-solving and those with more consensual styles of

management, who are more inclined to collaboration and involving stakeholders in the decision-making process. Furthermore, a construction manager's ability to effectively communicate with workers and other stakeholders is integral for resolving issues and can often be a deciding factor in resolving them in a timely and satisfactory manner.

Construction site managers, who oversee the work of crews on construction sites, are at an increased risk of suffering from workplace fatigue, stress, and depressive symptoms. This is due to the intense pressures they face to ensure their workforce works efficiently and to budget while dealing with the many ever-changing results of their environment.

Having the ability to communicate openly with colleagues is also vital for the well-being of a construction site manager. This allows for collaboration and problem-solving, which can help to reduce inefficiencies and improve overall project completion times. Additionally, strong communication skills can help construction site managers build relationships with their team, vendors, and stakeholders, making the completion of the project far easier.

In addition, the new competitive climates mean that organizations will have to revise their reporting, information and control systems and develop more flexible organizational structures [89]. In the words of Friberg:

"The management challenges posed by 1992 are complex and profound ... Managing uncertainty is always hard, always risky, always demanding. But it is, after all, what management is all about."

Undoubtedly, managers in the construction industry will also be faced with changing competitive climates.

6. Conclusions

A civil engineer is a professional, academically educated and practice-oriented who uses his scientific, technical and other pertinent knowledge to perform, with ethics, civil engineering acts, aiming to contribute to a sustainable world, with a better quality of life [13].

By imposing the necessity of this activity (Construction Management) be performed by duly qualified persons in terms of academic qualifications and professional experience, it is possible to minimize the risks inherent in construction work in general as regards the protection of public security and consumer interest, as well as the safeguard of protection of the environment and the urban environment, including town and country planning. The qualification requirements minimize also the risk of deficient quality of the construction and the mistrust of the consumers. Being a profession reserved, it is guaranted that the professionals have the right skills, knowledge and experience to carrie on this functions, being maximized the construction's quality, and guarantee to the satisfaction of the consumers and recipients of services, and the protection of the environment.

Minimising the risks and maximising the benifits have measures. These measures impose academic qualifications and professional qualifications and experience of the technicians. The Law nº 40/2015 from Portugal establish legal obligations for these professionals and in case of bad performance, they have administrative functions. The site director acts are defined according to the qualifications obtained e proved in accordance with Law nº 40/2015 by several professions in related areas. There are similar risks for comparable professions-Construction Control Surveyor, Project Coordinate and Project Author and the measures are similar for all because all these professions are regulated.

There are some reserved activites that are exclusively performed by professionals possessing a specific professional qualification. These activities show a very high degree of complexity, including the construction of structures like bridges, dams, railways, airports, etc. All this acts are reserved to special qualification and experience under the Low.

The construction industry should continuously improve its overall safety management strategy from the actual construction site. Companies need to integrate security design into their development strategy and raise awareness among their employees too. In particular, the construction manager of the construction industry shall supervise and manage the varied on-site construction conditions, continuously optimize the management measures,

and effects, and carry out various activities in a planned manner so that the project is completed on a regular basis by quality [52].

The stress of “being in the organization” is a major problem for nearly half of the reported cases in Europe, and the workload problems probably explain why the construction site manager spends insufficient time at home with the family. Career stress yet was rarely reported, perhaps because a buoyant jobs market exists, and the company is in a state of high growth. In these circumstances, one would expect overpromotion problems rather than underpromotion as a source of stress. Studies suggest that the construction industry needs to urgently address the problem of stress in its site managers. In terms of stress manifestations, one of the main issues seemed to be the high levels of anxiety, independent of grade level. This was predicted by the stress of role insecurity (fear of failure, mistakes, overpromotion, etc.), work overload, and dissatisfaction with extrinsic job factors (i.e. hours of work, job security, physical work conditions, fellow workers and the immediate boss).

‘innovation’ means the implementation of a new or significantly improved product, service, or process, including but not limited to production, building or construction processes, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations inter alia with the purpose of helping to solve societal challenges or to support the Europe 2020 strategy for smart, sustainable, and inclusive growth [90].

Traditional institutions like universities offer courses on academic and theoretical topics like math, English, and history. Their focus is on in-depth study, and the workload is very high. Above all that engineering courses is a still missing a golden key that can be studied and taught for example in the creation of civil or structural engineering curriculums, the people in charge sometimes do not understand the significance of adding multidisciplinary areas such as construction law that have not been necessarily related to civil or structural engineering disciplines. There are several causes for this. Graduates must understand how to operate legally in order to avoid costly litigation. In addition, in terms of professional fees, graduates should be aware of some legal fundamentals to prevent personal disadvantages. Despite this, construction law education plays only a modest part in civil and structural engineering schools. This might be due to the fact that legal training for engineering students does not appear to be inherently relevant. Furthermore, students’ workloads in civil and structural engineering degrees are exceptionally high, with little time given to specific technical courses and internships in programs. As a result, there is no

incentive to further lower it by offering multidisciplinary courses such as construction law [91].

To summarize, with the ongoing changes projected in Europe over the last century and into the new one, a new approach to leadership development is required. That new approach derives from earlier work on transactional leadership, which added to people's perceptions of ideal leadership. Transformational leadership is a worthy subject for training, education, and development as it emerges on the global stage at a time when change is the norm rather than the exception. Construction is a highly complicated industry with several challenges and issues. Construction management, as a subset of this business, has its own set of issues and solutions. Transformational leadership is as asset. And must be applying less passive/avoidant leadership and more transformational leadership appears to be an effective way for construction site managers to improve occupational safety in the industry.

6.1 Proposals

Trust on-site between the construction manager and workers is critical. To help resolve this issue, the construction manager should have a comprehensive onboarding program for all new hires to ensure that everyone understands the expected standards of work. Additionally, the manager should establish clear policies and procedures that clearly outline expectations, consequences, and rewards for workers. Further, a periodic performance review process can help the manager continuously assess the workers' capabilities and ensure they're meeting the established expectations. Finally, the manager should establish open communication channels with all workers to encourage honesty, transparency, and understanding.

In order to solve these problems, a construction manager must first identify and address the root cause of the difficulties. Safety should always be the top priority and the manager must ensure that safety protocols are followed at all times. Developing a balanced and skilful labour force is also important, increasing worker efficiency and hopefully reducing delays. To prevent theft, it is beneficial to have security measures in place. Weather-related problems can sometimes be managed through scheduling and timing, or by investing in long-term solutions such as utilising weather-proof systems or materials. Contractor disputes can be prevented by making sure that any contracts are airtight, and all conditions clearly outlined between both parties. Accidents can be managed and prevented by providing safety equipment, training, and regular inspections. Finally, financial constraints

can be managed by carefully monitoring budgets, prioritising necessities, and investing in cost-effective solutions.

Construction site managers, who supervise the work of workers on construction sites, are more likely to experience workplace tiredness, stress, and depressive symptoms. This is owing to their strong demands they are under to guarantee their personnel operates efficiently and under budget while dealing with the many ever-changing effects of their environment. Construction site managers' lack of physical activity throughout their shifts can be harmful to their health. Construction firms should guarantee that their employees are encouraged to receive enough physical exercise on their days off, such as by participating in a gym, recreational activities, or team sports. A construction site manager's capacity to speak honestly with co-workers is also critical to his or her well-being. It is critical that these employees have the opportunity to share their ideas, concerns, and insights with their co-workers in order for their work to operate well. Open and honest communication contributes to an environment of respect, trust, and understanding. This enables collaboration and problem-solving, which can aid in the reduction of inefficiencies and the improvement of total project completion timelines. Furthermore, great communication skills can assist construction site managers in developing relationships with their team, vendors, and stakeholders, making project completion significantly easier.

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I. Annex – A : Civil Engineering Terms' Translation [EN-PT]

PT	EN
Obra	Work/Construction site
Caderno de encargos	Charges/missions notebook
Empreitada	Construction contract
Empreiteiro	Contractor
Diretor de obra	Construction site manager/Work director/Construction director
Diretor de fiscalização	Inspection manager
Auto	Monthly report/document
Alvará	Building permit
Livro da obra	Workbook diary
Estaleiro	Shipyard

II. Annex – B : The Civil Engineering Charter [13]

European Council of Civil Engineers

CIVIL ENGINEERING CHARTER

1. A civil engineer is a professional, academically educated and practice-oriented who uses his scientific, technical and other pertinent knowledge to perform, with ethics, civil engineering acts, aiming to contribute to a sustainable world, with a better quality of life.

2. Examples of civil engineer acts are:

   At planning/design phase:
   - Structural design;
   - Building and other structures planning/design;
   - Tunnelling and ground solutions design;
   - Roads and other communication infrastructures planning/design;
   - Water and sanitary infrastructures planning/design;
   - River, coastal and offshore infrastructures planning/design;
   - Urban and environment planning/design;
   - Safety planning.

   During construction of buildings and infrastructures:
   - Technical supervision;
   - Construction and demolition management and supervision;
   - Materials production;
   - Safety, health and environment management.

   During operation and maintenance of buildings and infrastructures:
   - Building investments management;
   - Inspection, maintenance and repair;
   - Operation and decommissioning management.

   In general:
   - Research and teaching civil engineering;
   - Project and design management.

3. The civil engineer's knowledge is obtained from academic studies, professional experience and continuous professional development.

4. Based on the civil engineer's knowledge, the acts that each civil engineer should perform may be defined in each country by a national institution, where appropriate.

Approved at the 47th ECCE Meeting, Riga, 24 May 2008

III. Annex – C: Construction work's classification (ordinance 701-H)[25]

		CATEGORIAS			
		I	II	III	IV
I	EDIFÍCIOS				
I.1	ARQUITECTURA				
I.2	FUNDAÇÕES E ESTRUTURAS				
	Fundações directas em solo de boa qualidade	*			
	Fundações directas em solo de má qualidade		*		
	Fundações indirectas			*	
	Fundações especiais				*
	Estruturas de edificações: Correntes;		*		
	Com exigências especiais.			*	
	Estruturas de hospitais estádios, e grandes instalações desportivas ou culturais Com altura igual ou inferior a 30 metros;				*
	Estruturas de edifícios: Com altura igual ou inferior a 30 metros;		*		
	Com altura superior a 30 metros e igual ou inferior a 60 metros;			*	
	Com altura superior a 60 metros.				*
I.3	OBRAS DE ESCAVAÇÃO E CONTENÇÃO				
	Escavações com talude inclinado, sem necessidade de entivação, até um máximo de 6 m de altura, com contenção por muros de betão armado;	*			
	Escavações entivadas até 3 m de altura ou não entivadas acima de 6 m, com contenção por muros simples de betão armado		*		
	Escavações entivadas com mais de 3 m de altura com contenção por muros de escorados, ancorados ou com contrafortes betão armado			*	
	Escavações e contenções especiais				*
II	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS				
II.1	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS DE ÁGUAS E ESGOTOS				
	Instalações, equipamentos e sistemas de águas e esgotos para edifícios de Categoria I	*			
	Instalações, equipamentos e sistemas de águas e esgotos para edifícios de Categoria II		*		
	Instalações, equipamentos e sistemas de águas e esgotos para edifícios de Categoria III			*	
	Instalações, equipamentos e sistemas de águas e esgotos para edifícios de Categoria IV				*
II.2	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS ELÉCTRICOS (1)				
	Instalações, equipamentos e sistemas eléctricos para edifícios de Categoria I	*			
	Instalações, equipamentos e sistemas eléctricos para edifícios de Categoria II		*		
	Instalações, equipamentos e sistemas eléctricos para edifícios de Categoria III			*	
	Instalações, equipamentos e sistemas eléctricos para edifícios de Categoria IV				*
II.3	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS DE COMUNICAÇÃO				

	Instalações, equipamentos e sistemas de comunicações (voz, dados, imagem e outros) para edifícios de Categoria I	*			
	Instalações, equipamentos e sistemas de comunicações (voz, dados, imagem e outros) para edifícios de Categoria II		*		
	Instalações, equipamentos e sistemas de comunicações (voz, dados, imagem e outros) para edifícios de Categoria III			*	
	Instalações, equipamentos e sistemas de comunicações (voz, dados, imagem e outros) para edifícios de Categoria IV				*
	Centros de comunicação telefónica e ou equipamentos de telecomunicação e centros de informática				*
	Rede de cablagem estruturada e de transmissão de dados e voz				*
II.4	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS DE AQUECIMENTO, VENTILAÇÃO E AR CONDICIONADO (AVAC)				
	Instalações de AVAC simples, com recurso a unidades individuais, com potências térmicas inferiores a 12 kW	*			
	Instalações de AVAC com potências superiores a 12 kW e inferiores a 100 kW		*		
	Instalações de AVAC com potências iguais ou superiores a 1 000 kW			*	
	Instalações de AVAC em centros de informática e outras aplicações com de potência, hospitais, “salas limpas” equivalentes densidades				*
	Sistemas urbanos de fluidos térmicos				*
	Sistemas de cogeração				*
	Sistemas de aproveitamento de energia renovável associados a ciclos de absorção ou outros				*
	Sistemas de aproveitamento de energias renováveis para aquecimento ambiente ou de águas sanitárias			*	
II.5	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS DE GÁS				
	Pequenas instalações de gás em edifícios de Categoria I	*			
	Pequenas instalações de gás em edifícios de Categoria II		*		
	Pequenas instalações de gás em edifícios de Categoria III			*	
	Pequenas instalações de gás em edifícios de Categoria IV				*
	Redes de distribuição e condutas de gás			*	
II.6	INSTALAÇÕES, EQUIPAMENTOS E SISTEMAS DE TRANSPORTE DE PESSOAS E CARGAS				
	Instalações simples de equipamentos electromecânicos	*			
	Instalações de ascensores, escadas e tapetes rolantes			*	
II.7	SEGURANÇA INTEGRADA				
	Sistemas de segurança integrada				*
II.8	SISTEMAS DE GESTÃO TÉCNICA CENTRALIZADA				
	Sistemas de gestão técnica centralizada				*
III	PONTES, VIADUTOS E PASSADIÇOS				
III.1	Em infra-estruturas rodoviárias				
	Passadiços com vãos inferiores a 20 metros sem condicionamentos especiais	*			
	Passadiços com vãos entre 20 a 40 metros sem condicionamentos especiais		*		
	Passadiços com vãos superiores a 40 metros ou com geometria complexa e de qualquer vão			*	
	Pontes e e obras de arte similares, com vão único e igual ou inferior a 10 metros e viés superior a 70.º	*			
			*		

	Obras de Arte com vão máximo igual ou inferior a 40 metros e extensão menor que 400 m sem condicionamento de apoios				
	Pontes e viadutos que não sejam considerados segundo a regulamentação em vigor como pontes correntes para efeitos de análise sísmica, ou com vãos superior 40m ou com extensão superior 400 m			*	
	Pontes e viadutos fortemente enviesados ou com traçado planimétrico complexo, nomeadamente em meios urbanos			*	
	Pontes e viadutos com vão máximo igual ou superior a 60 metros, e com extensão superior a 400 metros				*
	Pontes e viadutos com vão máximo igual ou superior a 120 metros				*
III.2	Em infra-estruturas ferroviárias				
	Pontes e obras similares ferroviárias com vão único até 10m e viés superior a 70.º	*			
	Pontes e viadutos ferroviários com vão máximo igual ou inferior a 20m e viés superior a 70.º		*		
	Pontes e viadutos ferroviários com vão superior a 20m e inferior a 40m ou viés inferior a 70.º			*	
	Pontes e viadutos ferroviários com vãos superiores a 40m				*
	Pontes e viadutos ferroviários para velocidades de projecto superiores a 220km/h e vão inferior a 20m, sem viés			*	
	Pontes e viadutos ferroviários para velocidades superiores a 220 Km/h com vão superior a 20m ou viés inferior a 70.º				*
IV	ESTRADAS E ARRUAMENTOS				
	Caminhos municipais, vicinais e estradas florestais		*		
	Arruamentos urbanos com faixa de rodagem simples		*		
	Arruamentos urbanos com dupla faixa de rodagem			*	
	Estradas nacionais e municipais com faixa de rodagem simples ou dupla			*	
	Auto-Estradas				*
V	CAMINHOS-DE-FERRO				
	Ramais de caminhos-de-ferro de características correntes e feixes industriais		*	X	
	Vias-férreas de eléctricos, de metropolitano e de linhas de rede ferroviária nacional			*	X
	Catenária			*	X
	Vias-férreas para alta velocidade e muito alta velocidade				*
	Sinalização e equipamentos de segurança de vias-férreas convencionais			*	
	Sinalização e equipamentos de segurança de vias- férreas de alta velocidade				*
VI	AERÓDROMOS				
	Aeródromos			*	
	Aeroportos				*
	Sistemas de ajuda à navegação e controlo de tráfego aéreo				*
VII	OBRAS HIDRÁULICAS				
	Pequenos açudes de correcção torrencial e pequenas obras de regularização fluvial	*			
	Pequenas obras de rega ou de enxugo, sem obras de arte especiais	*			
	Obras de rega ou de enxugo envolvendo pequenas obras de arte ou instalações especiais		*		
	Obras importantes de correcção fluvial			*	
	Canais e vias navegáveis			*	
	Aproveitamentos hidroagrícolas e hidroeléctricos não envolvendo a construção de grandes barragens			*	

VIII	TÚNEIS				
	Túneis com escavação a céu aberto sem condicionantes geotécnicos especiais		*		
	Túneis com escavação a céu aberto com condicionantes geotécnicos especiais			*	
	Túneis subterrâneos em qualquer tipo de terreno			*	
	Túneis subterrâneos em zonas urbanas ou com intensa ocupação				*
	Túneis subaquáticos				*
IX	ABASTECIMENTO E TRATAMENTO DE ÁGUA				
	Condutas adutoras de água e de funcionamento gravítico, para aglomerados até 10 000 habitantes	*			
	Sistemas ou partes de sistemas de abastecimento de água (redes e ou adutores por bombagem), excluindo tratamento, de aglomerados até 10 000 habitantes.		*		
	Instalações simples de tratamento de água, incluindo apenas desinfecção e ou correcção de agressividade.		*		
	Sistemas ou partes de sistemas de abastecimento de água, excluindo tratamento, para mais de 10 000 habitantes			*	
	Estações de tratamento de água servindo até 50 000 habitantes desde que não apresentem exigências especiais quanto a operação e processos de tratamento e a automatismos (como ozonização ou adsorção por carvão activado).			*	
	Estações de tratamento de água para mais de 50 000 habitantes ou para população inferior mas envolvendo exigências especiais, como, por exemplo, processos de ozonização ou adsorção por meio de carvão activado.				*
X	DRENAGEM E TRATAMENTO DE ÁGUAS RESIDUAIS				
	Emissários de águas residuais de funcionamento gravítico, para aglomerados até 10 000 habitantes.	*			
	Sistemas ou partes de sistemas de águas residuais (redes), excluindo tratamento, de funcionamento gravítico, de aglomerados até 10 000 habitantes.		*		
	Instalações sumárias de tratamento de águas residuais, do tipo fossa séptica e órgão complementar ou tanque Imhoff e leitos de secagem.		*		
	Sistemas ou partes de sistemas de águas residuais, excluindo tratamento, de funcionamento gravítico, para mais de 10 000 habitantes.			*	
	Sistemas elevatórios de águas residuais				
	Estações de tratamento de águas residuais servindo até 50 000 habitantes por processos convencionais, com produção de efluentes de qualidade correspondente a tratamento secundário.			*	
	Sifões invertidos para águas residuais				
	Emissários submarinos				
	Estações de tratamento de águas residuais para mais de 50 000 habitantes ou para população inferior desde que a linha de tratamento integre processos não convencionais, por exemplo tratamentos avançados físico-químicos, ou de origem a efluentes de qualidade superior à resultante da aplicação de um tratamento secundário.				*
	Sistemas de reutilização de águas residuais				*
XI	RESÍDUOS URBANOS E INDUSTRIAIS				
	Remoções de resíduos sólidos, de âmbito restrito, simples	*			
	Sistemas de resíduos sólidos, excluindo tratamento, de aglomerados até 10 000 habitantes.		*		
	Estações de tratamento de resíduos sólidos servindo até 10 000 habitantes, sem exigências especiais e por processos de aterro controlado		*		

	Sistemas de resíduos sólidos, excluindo tratamento, para mais de 10 000 habitantes			*	
	Estações de transferência de resíduos sólidos			*	
	Estações de tratamento de resíduos sólidos para mais de 10 000 e até 50 000 habitantes, sem exigências especiais, ou para população inferior mas tendo dessas exigências.			*	
	Estações de tratamento de resíduos sólidos para mais de 50 000 habitantes ou para população inferior mas com exigências especiais.				*
	Sistemas de recuperação de energia a partir dos resíduos sólidos				*
	Sistemas de reutilização e reciclagem de resíduos tratados				*
	Estações de tratamento de resíduos perigosos				*
XII	OBRAS PORTUÁRIAS E DE ENGENHARIA COSTEIRA				
	Obras de acostagem (cais, pontes -cais, duques d'alba, pontões flutuantes)			*	
	Docas secas e eclusas				*
	Planos inclinados e plataformas de elevação			*	
	Rampas -varadouro		*		
	Quebra -mares			*	
	Esporões, defesas frontais e retenções de protecção marginal		*		
	Alimentação artificial de praias		*		
	Tomadas e rejeições de água em costa aberta			*	
	Tomadas e rejeições de água em estuários		*		
	Tubagens submarinas em costa aberta			*	
	Tubagens submarinas em estuários		*		
	Dragagens e depósito de dragados	*			
	Terraplenos portuários	*			
	Sinalização marítima — farolins, em costa aberta no estuário			*	
	Sistemas de ajuda à navegação e controlo de tráfego marítimo				*
XIII	ESPAÇOS EXTERIORES				
	Projectos de concepção, tratamento ou recuperação de:			*	
	Jardins privados e públicos				*
	Jardins e sítios históricos			*	
	Zonas Polidesportivas			*	
	Campos de golfe			*	
	Minas, pedreiras, saibreiras e areeiros			*	
	Parques infantis			*	
	Lagos artificiais			*	
	Pedonalização de ruas			*	
	Ciclovias				*
	Estabilização e integração de taludes			*	
	Matas		*		
	Compartimentação do campo			*	
	Parques de qualquer natureza			*	
	Loteamentos urbanos		*		
	Instalações industriais			*	
	Parques de campismo			*	

	Campos de golfe			*	
	Zonas desportivas, de recreio e lazer			*	
	Áreas envolventes do Património Cultural ou Natural			*	
	Espaços livres e zonas verdes urbanas			*	
	Enquadramentos de edifícios de vária natureza			*	
	Cemitérios		*		
	Áreas degradadas			*	
	Projectos de rega			*	
	Drenagem superficial			*	
	Obras de regularização fluvial e de linhas de drenagem natural			*	
	Edifícios para habitação, escolas, igrejas, hospitais, teatros, cinemas e outros			*	
	Hóteis e restaurantes				
	Conjuntos industriais			*	
	Grandes instalações de equipamentos técnicos		*		
	Integração de estradas de qualquer tipo (AE, IP, IC, EN, ER)			*	
	Arruamentos urbanos, vias e caminhos municipais			*	
	Aproveitamentos hidroagrícolas		*		
	Estações de tratamento de água e esgotos			*	
XIV	PRODUÇÃO, TRANSFORMAÇÃO, TRANSPORTE E DISTRIBUIÇÃO DE ENERGIA ELÉCTRICA				
	Produção (centrais com potências instaladas iguais ou inferiores a 5 kVA), postos de transformação com potências instaladas iguais ou inferiores a 500 kVA, redes de distribuição em baixa tensão de pequena dimensão.	*			
	Produção (centrais com potências instaladas superiores a 5 kVA e iguais ou inferiores a 1.000 kVA), postos de transformação com potências instaladas superiores a 500 kVA e iguais ou inferiores a 10 MVA, redes de distribuição de energia eléctrica em baixa tensão de média ou grande dimensão.		*		
	Produção (centrais com potências instaladas superiores a 1.000 kVA e iguais ou inferiores a 10 MVA), subestações, postos de transformação e de seccionamento com potências instaladas superiores a 10 MVA e iguais ou inferiores a 100 MVA, linhas eléctricas de média, alta ou muito alta tensão de pequena dimensão.			*	
	Produção (centrais com potências instaladas superiores a 10 MVA), subestações, postos de transformação e de seccionamento com potências instaladas superiores a 100 MVA, linhas eléctricas de média, alta ou muito alta tensão de média ou grande dimensão.				*
XV	REDES DE COMUNICAÇÕES				
	Redes de comunicações de pequena dimensão	*			
	Redes de comunicações de média e grande dimensão		*		

IV. Annex – D: Questionnaire form (Case study)

Pesquisa sobre Direcão de Obra

Esta pesquisa é para realizar um trabalho de dissertação para conclusão do curso de Eng.Civil

*Required

1. Por favor clique no link e lê o CONSENTIMENTO LIVRE: https://drive.google.com/file/d/1NNIUIls_hr3Uej6OIGZ_nLneODWErSz3/view?usp=sharing *

   Mark only one oval.

   ◯ Li e aceito.

2. Você aceita que as iniciais do seu nome apareça na minha dissertação? (Informação apenas para efeitos de investigação académica) *

   Mark only one oval.

   ◯ Sim
   ◯ Não

3. Por favor coloque seu nome completo aqui? *

   _____

4. A sua idade? *

   _____

5. Gênero? *

Mark only one oval.

- ◯ Masculino
- ◯ Feminino
- ◯ Prefiro não dizer

6. Você é diretor de obra que esta em execução ou já foi diretor de um projeto no passado? *

Tick all that apply.

- ☐ Na atualidade
- ☐ No passado

7. Qual é a empresa construtura responável pela execução da obra? *

_____

8. Em qual país se encontra ?

_____

9. Qual é a sua função? *

Tick all that apply.

- ☐ Diretor de obra da empresa construtora
- ☐ Diretor de obra adjunto da empresa construtora
- ☐ Diretor de obra por parte do dono de obra
- ☐ Diretor de fiscalização de obra

10. Obra pública ou privada ? *

Tick all that apply.

- ☐ Pública
- ☐ Privada

11. Tipo de obra ? *

Tick all that apply.

- [ ] Construção nova
- [ ] Reabilitação
- [ ] Demolição
- [ ] Conservção
- [ ] Reparação
- [ ] Infraestruturas
- [ ] Other: _____

12. Tem noção que existem softwares e programas que podem ser úteis para apoiar o diretor de obra? *

Mark only one oval.

- ◯ Sim
- ◯ Não

13. Já usou alguma vez algum instrumento informático de apoio à direção e gestão de obra? *

Mark only one oval.

- ◯ Sim
- ◯ Não

14. Pode identificar o instrumento utilizado e qual a sua utilidade ? (Se for mais do que um, pode referir todos) *

_____

_____

_____

_____

_____

15. Além das principais funções do diretor de obra: (1-Gestão de equipas 2-Materiais 3- Equipamentos 4-Subempreitadas) acha que as empresas exigem outras funções não técnicas. (se sim , pode explicar um pouco as situações referidas?) *

16. Há vários regulamentos e legislação a definirem as qualificações e as habilitações do Diretor de obra, Conhece? *

Mark only one oval.

- Sim
- Não

17. Se responder "Sim", identifica lhes por favor? {Tipo Códigos, Exigências e qualificações pela Comissão Europeia, Legislações nacionais adotadas (Portugal - França - Alemanha - Brazil - Moçambique - Angola - ...)}

18. Qual foi sua área de estudo? *

19. Durante quantos anos você estudou? *

Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ Other: _____

20. Com mestrado ou sem? *

Mark only one oval.

- ◯ Com
- ◯ Sem

21. Quantos anos de experiência teve até conseguir assumir o cargo de diretor de obra? *

Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ Other: _____

22. Quais são as dificuldades/desafios que mais enfrenta o diretor de obra? *

23. O que você gostaria de propor para melhorar esta profissão e torná-la mais eficiente e reconhecida? *

24. Sabemos que um dos desafios mais críticos são o stress/pressão e a necessidade de tomar decisões firmes e quase instantâneas. Como é que você enfrenta uma situação que tem estas características? *

25. Na sua opinião, quais são as características/personalidade que um diretor de obra deve ter? *

26. Dê 5 exemplos de algumas obras que já dirigiu e indique as suas tipologias e os valores globais das obras?

27. Por favor indique o que entende ser relevante para o exercício do cargo ?

Obrigado a todos os participantes que contribuiram no desenvolvimento desta dissretação.

"In Rome, construction managers were high esteem citizens, who achieved adulation and wealth. They could build a 50-kilometer long artificial waterway, which on average drops 34 centimeters per kilometer – through mountains and hills. All of it crosses a 360-meter divide, through a 20.000 m3 aqueduct, and all of it is still standing!"
(Niels)