# Internal benchmarking and investigation to formulate practical innovations in the Moroccan construction industry

**Khalil Idrissi Gartoumi** ( idrissi.gartoumi.khalil@gmail.com )
Universite Moulay Ismail, Ecole Nationale Superieure d'Arts et Metiers

**Mohamed Aboussaleh**
Universite Moulay Ismail, Ecole Nationale Superieure d'Arts et Metiers

**Smail Zaki**
Universite Moulay Ismail, Ecole Nationale Superieure d'Arts et Metiers

**Research Article**

**Keywords:** AECOO, Managerial and Technological Challenges, Construction improvement, Moroccan perspective

**Posted Date:** May 23rd, 2022

**DOI:** https://doi.org/10.21203/rs.3.rs-1625417/v1

# Abstract

The renovation of the Architecture, Engineering, Construction and Owner Operators (AECOO) industry is at the forefront of countries' concerns. Despite its important place in national economies, it suffers from several challenges. Faced with this paradox, rethinking inspiration has not attracted many countries like Morocco. Any improvement must be based on a thorough analysis for efficient solutions. In this context, the main objective of this paper is to trigger, investigate, and analyse the state and paradoxical aspects of the Moroccan construction industry (MCI). A triangular approach was conducted, consisting of a literature review, official documents, and a survey of 25 professionals and 15 academics in the sector. The results reveal two main failures, one is managerial and the other technological, and the enumeration of ambitions which are also conditioned by the emergence of technology and new managerial approaches. These findings provide a platform for understanding future interventions, support the literature and suggest avenues of research for neighbouring construction industries, developing countries, and Africa due to similarities with Morocco. Furthermore, it provides recommendations for future studies, especially a new research framework for MCI and other similar countries based on the implementation of Building Information Modelling and Lean Construction.


# 1. Introduction

Today, the Moroccan construction industry (MCI) plays a vital role in the economy’s growth, as do many countries. It is a vital sector. In terms of employment, it has contributed to creating 24,000 jobs in 2019 with a 2.1% annual increase, and 1 million jobs in total, with 55,000 companies in operation. In terms of investment, the consolidation of public investment continues with the programming of major infrastructure projects. Its contribution to GDP is about 6.2% [1, 2]. According to statistics, urbanisation rates tend to increase from 59.7% in 2013 to 67.8% in 2030 [3]. These rates represent a challenge for all stakeholders in the sector and require the development of an integrated, sustainable infrastructure delivered on time and with the desired quality. However, conventional design, calculation, and construction methods blur the ability of the MCI to overcome this and other internal and external challenges, putting the sector with its various Architecture, Engineering, Construction, Owner Operators (AECOO) trades in a delicate, outlier situation with a poor reputation.

Indeed, the Moroccan construction industry is a lever of the national economy. However, many specific challenges need to be addressed. The sector is a massive burden on the environment and water resources on the environmental front. And as a result of the large amount of waste produced during construction and infrastructure management, the construction industry creates a hazardous impact on the ecosystem [4]. One of the most important current debates on the construction industry’s challenges is the high energy cost deployed for the work. Comparing the price of one-kilowatt-hour electricity in Morocco to other countries, it is 27% higher than in France, 33% higher than in Turkey and Portugal, and 60% higher than in Tunisia [5]. On another note, the construction industry is characterised by a poor reputation, the dominance of quality defects, the lack of efficiency, the generation of cost overruns, and time overruns. It also suffers from the failure of close collaboration along the construction value chain

between the client, subcontractors, and stakeholders [6]. In addition, it has also become more complex, over-specialised, and competitive.

Despite the disadvantageous situation and the considerable presence of uncertainties that haunt construction throughout its life cycle, the evolution of Moroccan infrastructure is phenomenal. Whether it is roads, highways, railway stations, ports, airports... In practice, this evolution is concretised by the launch of megaprojects and strategic programmes. Such as the National Programme for Drinking Water Supply 2020–2027 (12.34 billion USD), containing the construction of twenty large dams, the Atlantic port of Dakhla (1.1 billion USD), and 800,000 social housing units (19.9 billion USD), and others.

As mentioned so far, the persistence of difficulties and failures goes hand in hand with the construction industry's ambitions, opportunities, economic development, and trades. Given these circumstances, there is undoubtedly a need to initiate research and create a platform for discussions around the paradoxical situation of the ACEOO industry in Morocco. All stakeholders should rethink the current state and renovate this sector. In this context, the following research questions arise:

Research Question 1: What is the nature of failures associated with the Moroccan AECOO industry?

Research Question 2: What are the ambitions of the Moroccan AECOO industry?

Research Question 3: How to overcome the failures, achieve the ambitions and renovate this industry?

Based on these questions, this paper is part of the global effort to propose and bring out improved approaches to the AECOO industry. It aims to create a knowledge base around the Moroccan case, trigger scientific discussions on the renovation of this potential sector, and judge the need for an overhaul allowing the substitution of the traditional construction industry by an integrated, intelligent, and sustainable construction industry. Therefore, this paper fills a gap in the literature by providing an overview and comprehensive aspects of the AECOO industry in Morocco. It carries the mission to unveil the paradoxical state of this industry in the era of future scientific production approaches capable of renovating it. This first of its kind generative study can be conducted for different countries or regions, especially those in Africa, developing countries, and countries where the situation is similar. In addition, it proves otherwise why many countries have accepted the emergence of new approaches such as Building Information Modelling (BIM), Lean Construction (LC), and CI 4.0 associated technologies.

# 2. Methods

In the absence of fundamental research on the Moroccan AECOO situation, it is improving and renovating. And the presence of weak scientific production according to the famous databases (Scopus, Web of Science, Google Scholar) on subjects related to the improvement of the performance and productivity of the economic sector. Hence the idea to conduct this fundamental study.

So, to act better and propose the right solutions to an unfavourable and paradoxical situation such as that of the AECOO industry, it was necessary first of all to analyse the existing situation and decipher all

the dimensions. We adopted the Five W's and How's (5W1H) approach, derived from quality management and the Lean philosophy. This constructive critical analysis tool is based on systematic questions [7]. Turning the problem in all directions results in the dimensions of the Moroccan construction industry that require study and clarification.

To explore each dimension, a triangulation approach is adopted as the primary approach of this study Fig. 1,2. The combined approaches to data collection are literature review, reports, and quantitative studies from public administrations, and a qualitative approach based on semi-structured interviews with different stakeholders in a construction project. Figure 3 summarises the data collection process through semi-structured interviews with the various stakeholders in a construction project. The data obtained are presented in the in-depth analysis of the MCI, ordered, and analysed in the discussion section.

# 3. The Construction Industry

The construction industry (CI), according to researchers, is considered a slow-growing industry with many problems [8], such as conflicting relationships, low productivity rates, and frequent failure to meet owner and customer expectations [9]. In contrast to the manufacturing industry, which has seen a significant increase in recent decades [10]. According to the authors [11], construction is unique and complex and covers a spectrum from slow, specific, and simple projects to fast, uncertain, and complex projects. Among the causes of this state, it is heterogeneous and enormously involved with projects exposed to uncertainty [12]. In addition, it is a highly fragmented industry and reluctant to accept changes in its current practice because CI is entirely different, resulting in high waste and low productivity [13]. Despite all the challenges that prevent the sector from spreading, it presents a locomotive for developing country’s economies.

Moreover, it is worth recalling that, following the great world crisis of 1929 or the time of the financial crisis of 2008, economic recovery policies were based on investment in public infrastructure and the construction sector [14]. Considered a pioneer and an essential element of economic growth, the construction industry, through all its trades, needs to be modernised for better performance. Aware of its added value on all scales, many countries have placed great importance on innovation in construction project management, the integration of sustainable concepts, and information technology. The awareness of this perception differs from country to country. In the Kingdom of Morocco, as in other countries of the world, the rethinking of innovation in this industry is timid and does not currently attract the interest of researchers and professionals.

# 4. Moroccan Construction Industry (Mci)

The case of Morocco is not too far from the global situation of the construction industry at the international level. The global paradox: numerous opportunities to strengthen its social and economic contribution to persistent challenges and difficulties. This prevents the creation of added value, the

maximisation of productivity, and the alignment with positive transformation and environmental requirements.

Having presented the problem and paradox of the construction industry and, in particular, of the MCI, it is time to proceed to an in-depth analysis of the MCI to properly study and examine in detail the different aspects and dimensions. The systematic questioning to identify the examination elements from the 5W1H tool is described in Table I, which consists of three columns. We have associated questions with the target to be revealed. The process results show the main parts and information related to the MCI. These are grouped in Fig. 1.

After the careful definition of the problem, the 5W1H tool allowed for a refined analysis of the MCI situation and the breakdown into small cells for further identification and description.

Table I

The Analysis grid 5W1H.

| 5W1H | The questions considered | Objectif and target |
|---|---|---|
| Q1: What | - What does the problem?<br>- What is this?<br>- What are the characteristics? | Identify the problem and its characteristics and create an initial idea of the actions taken. |
| Q2: Who | - Does it affect? Everyone?<br>- Who is involved in this?<br>- Who's got the problem?<br>- Who is interested in the result? | Determination and description of the actors and persons affected by the problem identified when responding to Q1. |
| Q3: Where | - Where did the problem occur?<br>- Where does this happen and apply?<br>- Where does the problem arise? | Describe the geographic position and commonality between the stakeholders (Q2) facing the play (Q1) state. |
| Q4: When | - When did the problem occur? | Specify the time envelope of occurrence of the problem and its current criticality. |
| Q5: Why | - Why did the problem occur?<br>- why does the problem persist?<br>Does the problem have a tendency, or is it related to something? | The Causes are contributing to the appearance of a problem (Q1), concerns (Q2), in (Q3), and during the period (Q4). |
| Q6: How | - How is the problem manifested?<br>- How does the problem occur?<br>- What consequences (& quality,<br>cost, delay, safety) are related to the problem? | In the context defined by the previous five questions, this question attempts to reveal the manifestations and consequences of the problem. |

The answers to the questions in Fig.1 result from the identification and understanding of the skeleton of the paradoxical situation of the Moroccan construction industry must be done essentially through the determination of the overall architecture, difficulties, challenges, and ambitions to prepare for any corrective action and intervention. As well, the resolution of this state matrix will positively affect the

precision of the critical and root aspects belonging to the life cycle of a construction project and subsequently require renovation and change to succeed in any initiative aimed at improving the performance of the act of building.

After framing the objective of this paper, it is obvious to proceed with a thorough identification and analysis of the essential elements of the LCI scope that form the basis of the triangular approach to data collection and analysis.

# 5. In-depth Analysis Of The Mci

## *A. Dimension 1: the architecture of the MCI*

**- Lever of the economy**

According to the National Federation of Real Estate Developers NFRED, the construction sector in Morocco, in total growth, can be counted among the most dynamic and promising segments in a significant way because it contributes on a large scale to the strengthening of the national economy. The sector contributes 6.2% to GDP and is the third-largest sector in employment. It employed more than one million people in 2017, i.e., 9.8% of the employed population. It is the driving force behind integration into the modern economy. It is often the top industrial occupation. It generates induced and proximity activities [15–17].

**- Some current disturbances**

However, construction productivity remains very weak in the third quarter of 2019, which is said to have been marked by a continuation of the unfavourable situation that has prevailed in the construction sector since 2012, as evidenced by the slowdown in most of the sector's critical economic indicators. In the first quarter of 2020, it lost 1,000 jobs (data recorded before the Coronavirus-19 pandemic restrictions) [2, 17–19].

**- Companies in the sector**

The sector is organised into two main economic activities: services and construction. This composition separates the actors who work together to carry out a project. We are currently talking about the actors who run the architecture, engineering, construction, and owner's operators (AECOO). The actors in the field offer a wide range of services to meet the need. These include housing, industrial and commercial buildings, roads, motorways, runways and airfields, bridges, installation and development of urban water networks, lighting and telecommunication networks, sanitation and drinking water supply, slope stability, and supports [20, 21]

**- The customer bases**

According to data from the National Federation of Building and Public Works (FNBTP), the demand components for CEA products are very varied. In the first place, administrations and public enterprises are the main customers through public contracts. The private sector market is the second-largest customer. Local and regional authorities are the third customer with less than one-tenth of the total turnover [22]. Finally, individuals and households represent less than 5% of the overall turnover. According to the Moroccan High Commission for Planning (HCP), contractors (Services or Construction) are organised into small enterprises (TPE), small and medium-sized enterprises (SME), and large enterprises (GE) [3].

**- Attraction of foreign investments.**

Morocco is considered one of the first destinations for foreign direct investments on the African continent. This attraction to foreign capital is explained by its political stability, its strategic geographical position, and its more or less dynamic economy [5, 23, 24]. According to the results published by the Office des Changes, the construction sector represents 17.2% of the foreign direct investments attracted.

## *B. Dimension 2: Challenges*

Like many developed and developing countries, the construction sector suffers from several challenges in different categories. A large number of published studies describe the failure, inadequacy, and inability of construction management models (time-cost-quality trade-offs, work breakdown structure, critical path methods, and earned value) to meet the triangle of time, budget, and desired quality, which is evident to practitioners and academics alike. This is evident in the recurrent negative experiences on projects manifested by endemic quality problems. The increase in litigation indicates that construction projects are inefficient systems with a reliable reputation [25–28]. The complexity and the multitudes of disciplines involved in a construction project lead many researchers and practitioners to argue that success comes from controlling the complexity of the project and its direct effect on the overall performance of the project [29, 30]. In general, there is a consensus that the focus of these performance difficulties and mismanagement is directly related to the complexity of construction projects in different countries [31].

Moreover, these countries are shifting in recent years to cushion the impact of continued population growth, rapid urbanisation, and the need for services to design and build Mega Housing Development Projects (MHDPs) [32], which will have a high level of complexity. And, of course, to unlock economic and social opportunities to energise and meet the needs of the individual, governments are programming strategic plans to build resilient and sustainable mega-infrastructure. A notable example is a strategic map of megaprojects in Morocco presented in the introduction to this document.

As mentioned at the beginning of this section, the construction industry’s challenges are multiple and mentioned in the literature review. Therefore, we seek to diagnose the specific difficulties of the MCI. To animate this paragraph in a practical, understandable, and lucid way, we are inspired by the graphic representation of the Ishikawa cause-effect method, which is one of the tools belonging to the quality

approach, and the Lean management list the challenges that influence this sector [33]. As shown in Fig. 1, the challenges identified come from the first two pillars of the triangular approach: 1- a review of the literature and official documents and 2- interviews with stakeholders. The adoption of the second source and not only the first one aims at completing the synthesised data, comparing and contrasting it with the opinions and visions of professionals and academics.

The results obtained from the first source are illustrated in the fishbone diagrams Fig.5. Those from the second source are shown in the second fishbone diagram Fig.6.

## *C. Dimensions 3: Ambitions*

The previous section has analysed the MCI in-depth in terms of difficulties. It has highlighted essential deficiencies in the construction life cycle that place this sector in an inability to face the growing challenges of specialisation, complexity, urbanisation rate, low profitability, lack of efficiency, client dissatisfaction, etc. The next step is to present the second part of the paradox of this economic sector. The prestigious position of the construction industry has maintained the source of mobilisation to fully realise the projects and meet the societal, economic, and environmental needs and ambitions desired. In clarifying dimensions from the 5W1H tool, this second aspect appeared essential in the delimitation of the problem and the in-depth analysis of the data from the different sources.

There was a remarkable willingness in economic indicators, official studies, and stakeholders to capitalise on this industry's strengths and current position, reinforce them, act proactively, and respond to weaknesses and threats to create a built environment that exploits opportunities. And is capable of delivering on strategic plans and customer motivations. The summary of the ambitions strongly measured in the semi-structured interviews is given below in the form of a tree-like mind map in Fig.7

# 6. Discussion

In most cases, companies in the construction sector are structured by activity or project. These are usually located in different regions and spread over several large geographical areas. The control of stocks, supplies, purchases, crews, and works is more complex because this task is carried out at the head office, which is usually far from the areas where the works are carried out. Profitability is penalised by the changes that accompany the work and the waste of materials on the one hand. On the other hand, the building is undergoing a vast increase in competition with more specialisation and too much complexity, affecting profitability.

Concerning the design of this study, it is remarkable that imbalances characterise the construction industry at all levels. These imbalances could be highlighted by analysing, on the one hand, the difficulties they face in the AECOO disciplines and, on the other hand, the ambitions and opportunities involving the importance occupied by CI and its considerable effect on economic indicators. The data collection shows that many difficulties prevent the field from reaching its full potential and ambitions to

achieve maximum benefit. The literature review from official documents, bibliography, and semi-structured interviews illustrate the AECOO industry's failures. It reveals various challenges that need to be overcome before thinking about the renovation of this sector. These challenges could be ordered into categories (CC) related to:

- C.C01: Procurement and purchasing (2P);

- C.C02: Management (M);

- C.C03: Planning, site preparation, control (2PC);

- C.C04: Informality and Defects (ID);

- C.C05: Stakeholder Collaboration (SC);

- C.C06: Waste, Loss, and Error (WLE);

- C.C07: Structures and Competition (SC);

- C.C08: Technology, Research, and Development (TR&D);

- C.C09: Economic, Social, Environmental (ESE);

- C.C10: Quality, Cost, Delivery (QCD).

So far, the difficulties revealed in this study are grouped into ten categories. According to the interview responses, most people working in the construction phase focused on the problems encountered on the construction sites and the challenge interval [C.C01-C.C04]. The respondents stated the lack of communication and permanent collaboration due to the serial flow construction process. According to the architects and engineers, the project’s design, study, and costing phase is cumbersome due to technical calculation errors. The time allocated to modifying plans is difficult due to the limitations of the software used. In their interventions, the academics summarised the challenges in the lack of support programmes on innovation, promotion of research and development, and the emergence of information technology. Thus, the lack of introduction of new technological and managerial trends for project management. It is noted in an intervention by two-three professors and four professionals that the lack of close coordination and the gap between the academic and professional environment constitutes a real challenge and conditions the quality and skills of the laureates to align with the new trends of the professional environment. Let us now consider the project owners, who have the role of guaranteeing the proper functioning of the project. They agreed that time overruns, cost overruns, and lousy quality influence the project's overall delivery, impact the social, economic, and environmental benefits, and threaten economic growth. One participant noted that the worst thing was that projects were abandoned after a completion rate that sometimes reached 60% during his professional career as a project owner. For their part, software suppliers indicated two main challenges; on the one hand, despite the renovation of tools for design, studies, coordination between the various trades, and project management,

stakeholders are still attached to traditional methods. On the other hand, structuring projects and competition prevents companies from opening up to new tools and software or implementing the new approach.

Looking at the CI professions in Morocco, it has experienced a boom this decade, according to national surveys, which is characterised by an increase in the creation of architectural firms, engineering offices, and construction companies, despite many difficulties. These new actors are generally small and work in the informal sector. This has the consequence of reinforcing the persistence of several limitations, notably structural and undermining this sector's ambitions and expectations.

Many aspects emerge from this analysis of the difficulties/challenges tab and the other of the ambition and potential of the LCI. It appears that urgency is indicated to anticipate the missing time, reposition itself in a framework of change, and rethink the construction life cycle at all scales. The above findings in terms of expectations and ambitions give the impression that several integrated remedial perspectives can create a linkage to promote this industry and push it forward as a pioneering sector and driver of the economy and job creation. These perspectives will be promising solutions to overcome difficulties, and enhance reputation and customer focus.

They were proceeding by affinity ranking of the ten proposed categories. Two main classes float to the surface. The first class is technological, and the second is managerial. It is noteworthy that the prospect of developing potential areas, reducing the impact of challenges, and meeting stakeholder expectations rely mainly: on the deployment of advanced technologies, the adoption of waste minimisation approaches, enabling continuous process improvement, and the search for integrated collaborative management models throughout the construction life cycle, from design to demolition.

Moreover, this state of affairs is no longer limited to the case of Morocco, so it is essential to reconcile and accentuate the state of the construction industry on a global scale. As far as the construction industry is concerned, it is paradoxical. Since it plays a significant role in every national economy and many other industries, it depends on purchasing and supplying products. Reducing or eliminating waste in the industry would result in considerable cost savings for the industry and society [34]. It is considered a reliable indicator that reflects the economic conditions in each country [35].

However, over the past three decades, the construction sector has become apparent, consuming many natural resources, accounting for more than 40% in the 1990s [36]. Today, this Fig is only about 32% [37–40]. The construction industry contributes 38% of all energy-related greenhouse gas emissions [41]. In addition to this consumption, the construction industry is also responsible for a quarter of the solid waste generated worldwide. This Fig can reach higher proportions in developing countries like Brazil, where the construction industry produces more than 60% of waste [42]. In Europe, buildings account for over 40% of energy consumption [42]. This happens because the construction sector mainly adopts a linear economic model of "take, make, throw away," using materials to construct buildings and throwing them away at the end of their life, as they are assembled for single-use and do not retain the potential for reuse [38, 43, 44].

In contrast, another economic model gaining attention in recent decades is the circular economy, whose founding principles offer better resource management [43, 45–47]. The situation in Morocco is no longer one of the construction industry at odds with environmental requirements. It is even worse, as many government studies have pointed to the detrimental effect of the construction industry and its misalignment with ecological perspectives.

In support of these recent findings on the paradoxical state of the MCI, several researchers argue that fast, complex, and uncertain projects cannot be managed by conventional means and that fast-track projects with long and complicated supply chains involving many actors and subject to multiple and significant design changes, processes and complex flow management fail miserably.

In the case of the construction industry [48, 49], it has been reported that the construction industry is heterogeneous and highly involved with projects that are exposed to uncertainty in design and planning, the presence of various stakeholder interests, resource availability, environmental factors, the country's economy, and statutory regulations. As a result, the industry is characterised by delays and has often suffered from cost and time overruns [48, 49]. Needless to say, the CI has an unreliable reputation and low productivity [26].

In addition to this, there has been no significant difference in the construction industry for a long time. This is confirmed by the labour productivity and low profitability, which has not exceeded 5% [20, 50]. This means that the margin of error is not acceptable, and facility management costs are meagre. This result is very significant compared to the series of megaprojects launched in Morocco. Indeed, the assembly of the fund and the financial solvency is complicated and proportional to the size of the project, which makes the project unacceptable for any error or source of over-cost. According to professionals interviewed, in Moroccan reality, many projects have been abandoned, and others are at risk of stopping, ac

In an era of global effort to overcome challenges, take full advantage of many industrial transformations, and adopt good resource management strategies, the construction industry faces problems and difficulties. Comparing the progress made by multiple sectors in integrating innovative technologies such as the trend of digitalisation, automation, and increased use of information and communication technologies (ICT) as the central concept of Industrial Revolution (IR) 4.0 [51], the construction industry is still reluctant to integrate these aspects into its current practices [52]. And it is still struggling to adopt IR 4.0 concepts despite the apparent benefits [6]. Another essential manifestation of inefficiency in the construction sector is the cost overruns resulting from delays and non-delivery and the waste of construction materials [53]. This waste of construction materials has been specifically identified as having severe negative impacts on the ecosystem [54–56]. Therefore, the construction industry still has many adverse effects on the environment and natural and ecological resources [57]. This calls into question attempts and approaches to ensure the sustainability and reconciliation of the built environment with economic, social, and environmental indicators. And what is waiting in Morocco to think about overcoming these challenges?

In particular, the above points have been made to scientifically judge the contradictory situation experienced by the MCI as well as other countries and to create a clear argument for the inevitability of adopting radical changes at a time when technological change is phenomenal, economic, social, and environmental added value is in high demand and improving the performance of infrastructure management processes is indispensable.

They are looking at the challenges and ambitions identified in the triangular approach. There is a priority convergence for overcoming challenges and achieving ambitions based on accepting the synergistic use of a new technological and managerial practice. In this synthetic context, many countries have been thinking of renovating their AECOO system and adapting a thorough overhaul to improve performance, deploying new technologies and positive management processes throughout the construction life cycle that can bring the construction sector into full compliance with sustainable development objectives. The path of change being taken by many countries and the exploration of the emergence of new management revolutions, led by Lean Construction (LC) and other technologies based on information technology deployments leveraged by using Building Information Modelling (BIM).

Lean Construction has been widely adopted to efficiently deliver construction projects as a process-based management approach derived from the Toyota Production System (TPS) [58–60]. Lean concepts have been introduced in Australia, Brazil, Denmark, Ecuador, Finland, Peru, Singapore, the UK, the USA, and Venezuela [61]. As established by [62], the Lean construction technique allows more to be done but less of everything. Lean uses less human effort, equipment, time, and space [63]. The lean manufacturing approach has also been an essential part of the construction literature [57, 64, 65]. Many authors confirm that there are as many Lean tools that can lead to the same success that this management style brings to the manufacturing industry in minimising sources of waste, reducing costs, and contributing to the timely delivery of projects, as well as meeting the needs of customers and prime contractors[66–68].

In turn, BIM is being implemented in many countries, e.g., the United States (USA), the United Kingdom (UK), Australia, Hong Kong, Denmark, Norway, Finland, and Singapore [69–71]. Singapore's Building and Construction Authority (BCA) has improved productivity by 20-30% by 2020. It has mandated BIM as an essential technology tool for improving productivity [72, 73]. The General Services Administration (GSA) in the United States is an international stakeholder in promoting BIM adoption for public sector projects. It has also developed a set of BIM guidelines for better commissioning. Elsewhere in the world, 78% of Danish architectural and engineering (AE) firms have used BIM for conflict detection, 3D visualisation, and BIM performance [74]; this plays a crucial role in improving the effective collaboration of the project team to meet client requirements [75, 76]. BIM is synonymous with new concepts and practices, greatly enhanced by innovative information technologies and business structures, significantly reducing waste and inefficiency in the construction sector [77]. It allows knowledge resources to be shared for information about a facility that provides a reliable and practical basis for decisions throughout its life cycle, defined from initial design to demolition. This decision support capability benefits the integrated creation of a virtual model, analysed and visualised by all stakeholders [78].

It follows from the literature reported and consultations conducted analysing the AECOO process in Morocco and some common aspects of the international fabric, the unanimity on the vital role of the construction industry for the overall development of countries, and the realisation of social and economic benefits. On the other hand, there is agreement on the persistence of several difficulties and challenges of either a technological or managerial nature. The actual results found are significant in at least two parts. A- the real challenge before the Moroccan AECOO is to compromise the current need for the built environment, the remarkable failures, and the much-hoped-for ambitions. B- the potential and capacity of LC and BIM to create a successful opportunity to overcome these challenges and improve the construction industry's performance to achieve the aspirations that are expected of it as a driver of the national economy. The latter outcome (b) is to be explored in future research. This new research framework is generic and could be carried out for other countries similar to Morocco while respecting the particularities of each country. This Framework has a lot of scientific and professional potential.

Moreover, all the people involved in the qualitative approach expressed their willingness to participate in the MCI renovations. What is surprising is that according to the closing question on the level of awareness about BIM and LC, 72.5% expressed that they are aware of BIM, and 22.5% are aware of LC. These responses reinforce the potentiality of the Framework to explore and investigate the issues of BIM and or LC implementation for the Moroccan construction industry.  In addition, the subject is being explored internationally, and this is evident from the emergence and growth of recent scientific output concerning this subject.

# 7. Conclusions

This article has made it possible to identify and map the critical aspects of the understanding of the construction sector in Morocco, intending to prepare a rigid platform to target and carry out any future intervention relating to the improvement of the performance of this sector, which is a lever for the national economy. Indeed, the results show the tangible contribution of the construction sector to the Moroccan economy through job creation, added value, and professional insertion. However, the economic indicators are decreasing over a long period, and many difficulties and failures at several levels remain, thus constituting weak points and future threats. Through the synthesis of challenges, the construction sector shows the persistence of two main categories of challenges, (a) the managerial challenge and (b) the technological challenge.

Evolving AECOO is a desire of all actors and countries worldwide to meet technological change demands, which are phenomenal, and embrace change to create more economic, social, and environmental value. Achieving this level can only be done by exploiting the strengths and opportunities that arise and absorbing the waste that results from construction. The results suggest a real opportunity to achieve ambitions and overcome challenges, which lie in adopting managerial and technological perspectives. This study contributes to a collective understanding among stakeholders of the first steps to reposition the MCI as a potential player in sustainable development issues. And for the scientific community, this paper triggers a new research framework for exploring and investigating remedial solutions and

renovations in the construction industry. At the top of this Framework, one of the spin-offs that follow trivially is the exploration of the linkage of BIM and LC, as these are two new approaches adopted, which have proven their potential in many countries in contributing to the achievement of economic objectives, social and ecological impacts of construction projects, and helping to mitigate the adverse effects of non-value-added construction activities.

Given the above, it will be a fruitful area of research to use the platform provided by this paper to discover and analyse the impact of the implementation of LC and BIM on AECOO in Morocco and how the emergence of these two approaches can be achieved while adapting and respecting the particularity of the Moroccan context. Further research is therefore needed to understand more about the relationship of these approaches to the Moroccan construction industry. Furthermore, it is relevant to other African and developing countries because of their similarities with their geographical location. Also, the new research framework proposed as a future extension of this study could be applied in other countries where the challenges identified are similar. As this study is limited to the Kingdom of Morocco, future studies should be conducted to verify the existence of similar challenges and ambitions of AECOO in other countries.

## Declarations

# Competing interests:

No conflict of interest exists.

# Funding:

No funding was received for this work

# Author’s contributions:

KIG collects and analysed data. KIG writes the manuscript.  MA and SZ contributed to data interpretation. MA and SZ were the supervisors. The authors read and approved the submission.

## References

1. Harrou K (2019) TABLEAU DE BORD SECTORIEL DEL’ÉCONOMIE MAROCAINE
2. HCP (2019) Economic Outlook N° 35
3. HCP (2019) National Business Survey 2019
4. Singh S, Kumar K (2019) Review of literature of lean construction and lean tools using systematic literature review technique (2008–2018). Ain Shams Engineering Journal. https://doi.org/10.1016/j.asej.2019.08.012
5. El ML, Iscae H (2002) Attraction de l’investissement étranger et dynamique de l’économie marocaine

6. Oesterreich TD, Teuteberg F (2016) Understanding the implications of digitisation and automation in the context of Industry 4.0: A triangulation approach and elements of a research agenda for the construction industry. Computers in Industry 83:121–139. https://doi.org/10.1016/j.compind.2016.09.006
7. Hohmann C (2015) Lean management : Outils - Méthodes - Retours d'expériences - Questions/Réponses. https://www.eyrolles.com/Entreprise/Livre/lean-management-9782212553819/. Accessed 29 May 2021
8. Sarhan S, Fox a (2013) Barriers to Implementing Lean Construction in the UK Construction Industry. The Built & Human Environment Review 6:1–17
9. Andersen B, Belay AM, Seim EA (2012) Lean construction practices and its effects: A case study at st olav's integrated hospital, Norway. Lean Construction Journal 2012:122–149
10. Farrell AA and P, School (2019) INTEGRATING H&S REGULATIONS INTO GREEN BUILDING RATING TOOLS FOR MORE SUSTAINABLE OUTCOMES: THE CASE OF THE PEARL RATING SYSTEM (ESTIDAMA) ADOPTED IN ABU DHABI, UAE A.
11. Ballard G, Howell G (1998) What Kind of Production Is Construction ? 6th Annual Conference of International Group of the Lean Construction, Guaruja, Brazil, 13-15 August 1–15
12. Akinradewo OI, Oke AE, Aigbavboa CO, Ndalamba M (2018) Benefits of adopting lean construction technique in the South African construction industry. Proceedings of the International Conference on Industrial Engineering and Operations Management 2018:1271–1277
13. Abdullah S, Razak A, Bakar A, et al (2009) Towards producing best practice in the Malaysian construction industry: the barriers in implementing the Lean Construction Approach. Building 1–15
14. Khalfaoui A, Zenansi M (2014) Le secteur du BTP au Maroc : Analyse des difficultés. 13–30
15. High Commission of Planning (2021) Morocco 2030. https://www.hcp.ma/downloads/Maroc-2030_t11885.html. Accessed 10 Jun 2021
16. HCP (2012) Economic surveys : Buildings and public works
17. HCP (2020) BUSINESS CONDITIONS NOTE N°36 - APRIL 2020
18. HCP (2020) Briefing Note on the Labour Market Situation in the First Quarter of 2020
19. HCP (2017) NATIONAL ECONOMIC STRUCTURE SURVEY 2015 : MAIN RESULTS FROM THE MANUFACTURING SECTOR
20. BTP Banque (2017) Analyse Financière 2017 des entreprises du BTP Performances financières des entreprises du BTP
21. Eddine MJ (2014) Le Secteur des BTP au Maroc : Aspects économiques et Sociaux. 31–46
22. Benhamane EM (2017) El Mouloudi Benhamane , Le Secteur de la construction au Maroc :
23. Larbi M, Harras E, Hmioui PA, Taghzouti A (2002) Environnement des affaires et attraction de l ' investissement international : Le cas du Maroc. 29–53
24. Youssef E (2019) The Construction Industry in Morocco : An economic analysis. 10:23–25. https://doi.org/10.9790/5933-1002022325

25. Koskela L (2000) An exploration towards a production theory and its application to construction. VTT Publications
26. Fakhimi AH, Sardroud JM, Azhar S (2016) How can lean, IPD and BIM work together? ISARC 2016 - 33rd International Symposium on Automation and Robotics in Construction 67–75. https://doi.org/10.22260/isarc2016/0009
27. Bertelsen S, Sacks R (2007) Towards a new understanding of the construction industry and the nature of its production. Lean Construction: A New Paradigm for Managing Capital Projects - 15th IGLC Conference 46–56
28. Abdelhamid TS, El-Gafy M, Salem O (2008) Lean Construction: Fundamentals and Principles. American Professional Constructor Journal 4:8–19
29. Xia bo, Chan AP c. (2012) Measuring complexity for building projects: A Delphi study. Engineering, Construction and Architectural Management 19:7–24. https://doi.org/10.1108/09699981211192544
30. Ochieng E, Hughes L (2013) Managing Project Complexity in Construction Projects: The way Forward. Journal of Architectural Engineering Technology 02:1–2. https://doi.org/10.4172/2168-9717.1000e111
31. Gidado KI (1996) Project complexity: The focal point of construction production planning. Construction Management and Economics 14:213–225. https://doi.org/10.1080/014461996373476
32. Khodeir LM, Nabawy EM (2021) Responsive human resource framework for design and building of mega housing development projects in Egypt. Ain Shams Engineering Journal. https://doi.org/10.1016/j.asej.2020.09.025
33. Liliana L (2016) A new model of Ishikawa diagram for quality assessment. IOP Conference Series: Materials Science and Engineering 161:. https://doi.org/10.1088/1757-899X/161/1/012099
34. Ansah RH, Sorooshian S, Mustafa S bin (2016) Lean construction: An effective approach for project management. ARPN Journal of Engineering and Applied Sciences 11:1607–1612
35. Sorooshian S (2014) Sorooshian S. Delay-based Reliability Analysis on Construction Projects
36. Rees WE (1999) The built environment and the ecosphere: A global perspective. Building Research and Information 27:206–220. https://doi.org/10.1080/096132199369336
37. Tauriainen M, Marttinen P, Dave B, Koskela L (2016) The Effects of BIM and Lean Construction on Design Management Practices. Procedia Engineering 164:567–574. https://doi.org/10.1016/j.proeng.2016.11.659
38. Benachio GLF, Freitas M do CD, Tavares SF (2020) Circular economy in the construction industry: A systematic literature review. Journal of Cleaner Production 260:121046. https://doi.org/10.1016/j.jclepro.2020.121046
39. Rees WE (1999) The built environment and the ecosphere: A global perspective. Building Research and Information 27:206–220. https://doi.org/10.1080/096132199369336
40. Yeheyis M, Hewage K, Alam MS, et al (2013) An overview of construction and demolition waste management in Canada: A lifecycle analysis approach to sustainability. Clean Technologies and

Environmental Policy 15:81–91. https://doi.org/10.1007/s10098-012-0481-6

41. Forum WE (2021) Green Building Principles: The Action Plan for Net-Zero Carbon Buildings
42. Akanbi LA, Oyedele LO, Omoteso K, et al (2019) Disassembly and deconstruction analytics system (D-DAS) for construction in a circular economy. Journal of Cleaner Production 223:386–396. https://doi.org/10.1016/j.jclepro.2019.03.172
43. EMF (2015) Towards a Circular Economy: Business Rationale for an Accelerated Transition. Ellen MacArthur Foundation (EMF) 20
44. Cheshire D (2019) APPLYING THE CIRCULAR ECONOMY TO THE BUILT ENVIRONMENT. RIBA Publishing
45. Salama W (2017) Design of concrete buildings for disassembly: An explorative review. International Journal of Sustainable Built Environment 6:617–635. https://doi.org/10.1016/j.ijsbe.2017.03.005
46. Ellen MacArthur Foundation (2015) Why the circular economy matters. Delivering the Circular Economy: A Toolkit for Policymakers 19–32
47. Hopkinson P, Chen HM, Zhou K, et al (2018) Recovery and reuse of structural products from end-of-life buildings. Proceedings of the Institution of Civil Engineers: Engineering Sustainability 172:119–128. https://doi.org/10.1680/jensu.18.00007
48. Weber A, Harrison TM, Sinnott L, et al (2018) Associations between Nurse-Guided Variables and Plasma Oxytocin Trajectories in Premature Infants during Initial Hospitalization. Advances in Neonatal Care 18:E12–E23. https://doi.org/10.1097/ANC.0000000000000452
49. Ballard G, Howell G (1994) Implementing lean construction: stabilising workflow. Lean construction 101–110
50. BTP BANQUE (2020) Performance of construction companies
51. Meško M Fundamental changes in the organisational processes: Industry 4.0 case study
52. Alaloul WS, Liew MS, Zawawi NAWA, Kennedy IB (2020) Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. Ain Shams Engineering Journal 11:225–230. https://doi.org/10.1016/j.asej.2019.08.010
53. Hussin JM, Abdul Rahman I, Memon AH (2013) The Way Forward in Sustainable Construction: Issues and Challenges. International Journal of Advances in Applied Sciences 2:. https://doi.org/10.11591/ijaas.v2i1.1321
54. Jaillon L, Poon CS, Chiang YH (2009) Quantifying the waste reduction potential of using prefabrication in building construction in Hong Kong. Waste Management 29:309–320. https://doi.org/10.1016/j.wasman.2008.02.015
55. Guthrie P, Mallett H (1995) WASTE MINIMISATION AND RECYCLING IN CONSTRUCTION - A REVIEW
56. Ulanowicz RE, Goerner SJ, Lietaer B, Gomez R (2009) Quantifying sustainability: Resilience, efficiency and the return of information theory. Ecological Complexity 6:27–36. https://doi.org/10.1016/j.ecocom.2008.10.005

57. Dallasega P, Rauch E (2017) Sustainable construction supply chains through synchronised production planning and control in engineer-to-order enterprises. Sustainability (Switzerland) 9:. https://doi.org/10.3390/su9101888
58. Tommelein ID (2015) Journey toward Lean Construction: Pursuing a Paradigm Shift in the AEC Industry. Journal of Construction Engineering and Management 141:04015005. https://doi.org/10.1061/(ASCE)co.1943-7862.0000926
59. Koskela L (1992) Application of the new production philosophy to construction. 72:
60. Li L, Li Z, Li X, Wu G (2019) A review of global lean construction during the past two decades: analysis and visualisation. Engineering, Construction and Architectural Management 26:1192–1216. https://doi.org/10.1108/ECAM-03-2018-0133
61. Ballard G, Howell GA (2003) Lean project management. Building Research and Information 31:119–133. https://doi.org/10.1080/09613210301997
62. Womack JP, Jones DT (1997) Lean Thinking—Banish Waste and Create Wealth in your Corporation. Journal of the Operational Research Society 48:1148–1148. https://doi.org/10.1038/sj.jors.2600967
63. Akinradewo OI, Oke AE, Aigbavboa CO, Ndalamba M (2018) Benefits of adopting lean construction technique in the South African construction industry. Proceedings of the International Conference on Industrial Engineering and Operations Management 2018:1271–1277
64. Babalola O, Ibem EO, Ezema IC (2019) Implementation of lean practices in the construction industry: A systematic review. Building and Environment 148:34–43. https://doi.org/10.1016/j.buildenv.2018.10.051
65. Smith JP (2015) A case study on design science research as a methodology for developing tools to support lean construction efforts. Proceedings of IGLC 23 - 23rd Annual Conference of the International Group for Lean Construction: Global Knowledge - Global Solutions 2015-Janua:517–526
66. Howell G (1999) What is lean construction. Concurrent Engineering 7:1–10
67. Tezel A, Koskela L, Aziz Z (2018) Current condition and future directions for lean construction in highways projects: A small and medium-sized enterprises (SMEs) perspective. International Journal of Project Management 36:267–286. https://doi.org/10.1016/j.ijproman.2017.10.004
68. Huovila P, Koskela L (1998) Contribution of the principles of lean construction to meet the challenges of sustainable development. … International Group for Lean Construction … 1–13
69. Latiffi AA, Mohd S, Kasim N, Fathi MS (2013) Building Information Modeling ( BIM ) Application in Malaysian Construction Industry. 2:1–6. https://doi.org/10.5923/s.ijcem.201309.01
70. Olugboyega O, Windapo A (2019) A Comprehensive BIM Implementation Model for Developing Countries. Journal of Construction Project Management and Innovation 9:83–104. https://doi.org/10.36615/jcpmi.v9i2.187
71. Li X, Wu P, Shen GQ, et al (2017) Mapping the knowledge domains of Building Information Modeling (BIM): A bibliometric approach. Automation in Construction 84:195–206. https://doi.org/10.1016/j.autcon.2017.09.011

72. Nath T, Attarzadeh M, Tiong RLK, et al (2015) Productivity improvement of precast shop drawings generation through BIM-based process re-engineering. Automation in Construction 54:54–68. https://doi.org/10.1016/j.autcon.2015.03.014
73. Khalil IG, Mohamed A, Smail Z (2021) Building Information Modelling in Morocco: Quo Vadis? In: 2021 Third International Sustainability and Resilience Conference: Climate Change. pp 479–483
74. Idrissi Gartoumi K, Aboussaleh M, Zaki S (2022) The workability and usefulness of building information modelling based design for building performance. Materials Today: Proceedings. https://doi.org/https://doi.org/10.1016/j.matpr.2022.01.312
75. European Commission (2019) European Construction Sector Observatory: Building Information Modelling in the EU construction sector. European Construction Sector Observatory 22
76. MARTON J, ALFARO PHG, HARTY J (2019) Exploring Bim Intelligence Further With Itwo. Building Information Modelling (BIM) in Design, Construction and Operations III 1:255–267. https://doi.org/10.2495/bim190221
77. Benz SM (1997) The Project Manager's CADD Survival Guide. The Project Manager's CADD Survival Guide. https://doi.org/10.1061/9780784402474
78. Khalil IG, Mohamed A, Smail Z (2021) Building Information Modeling for rural road design: a case study. In: 2021 16th International Conference on Electronics Computer and Computation (ICECCO). pp 1–7

# Figures

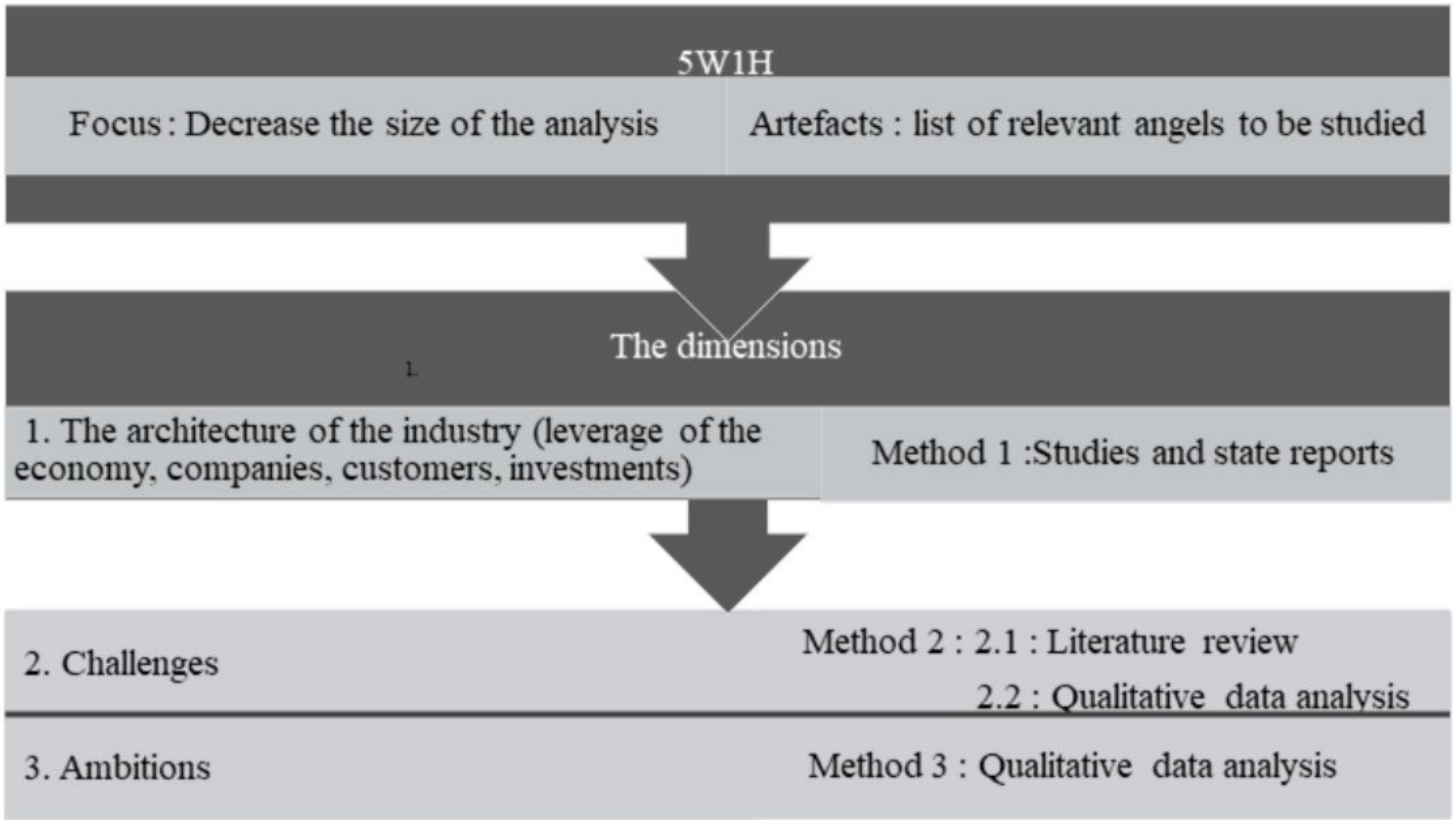


**Figure 1**

Research design

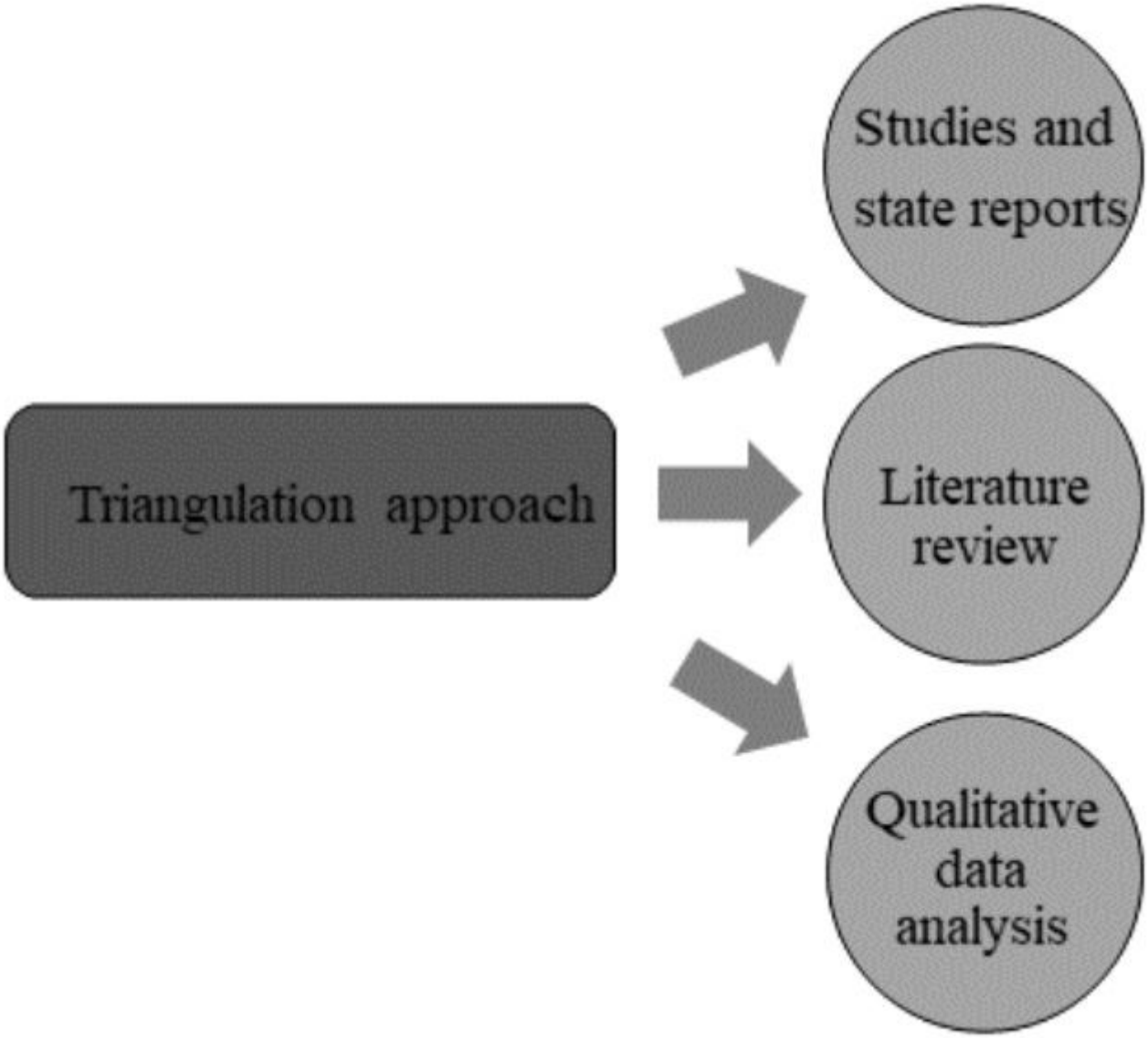



**Figure 2**

Triangular approach

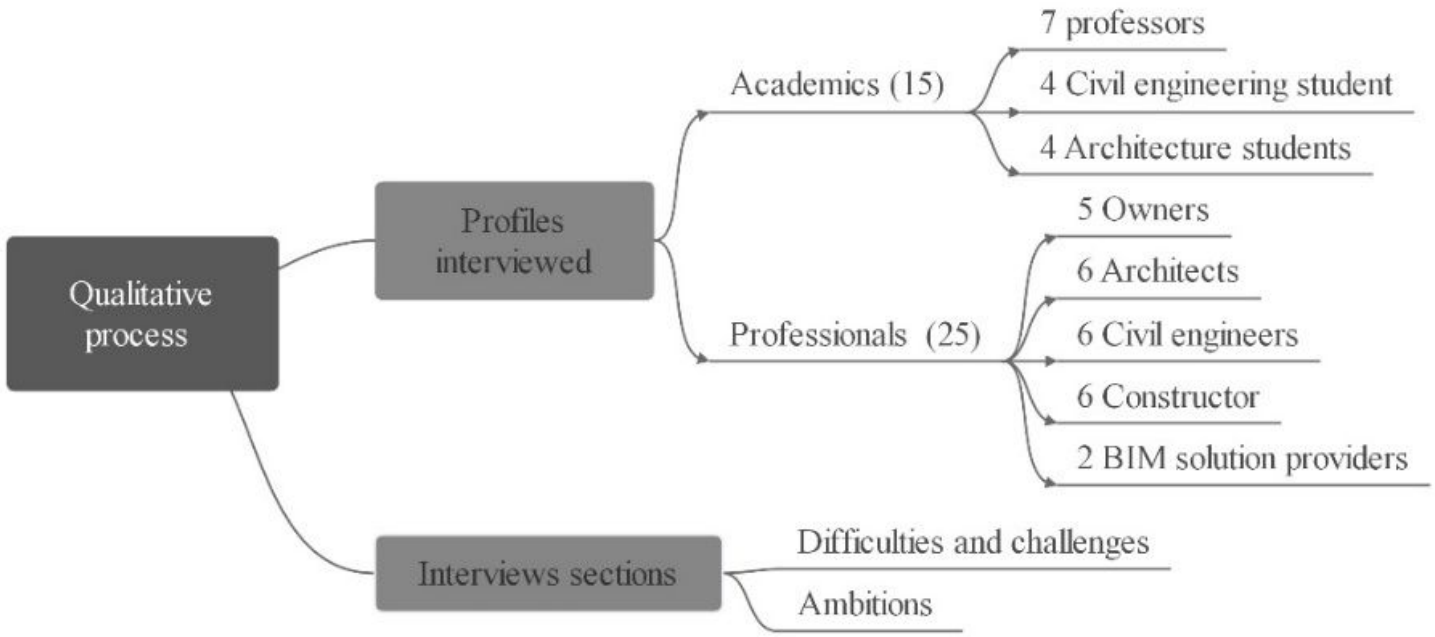



**Figure 3**

Qualitative process of the triangular approach

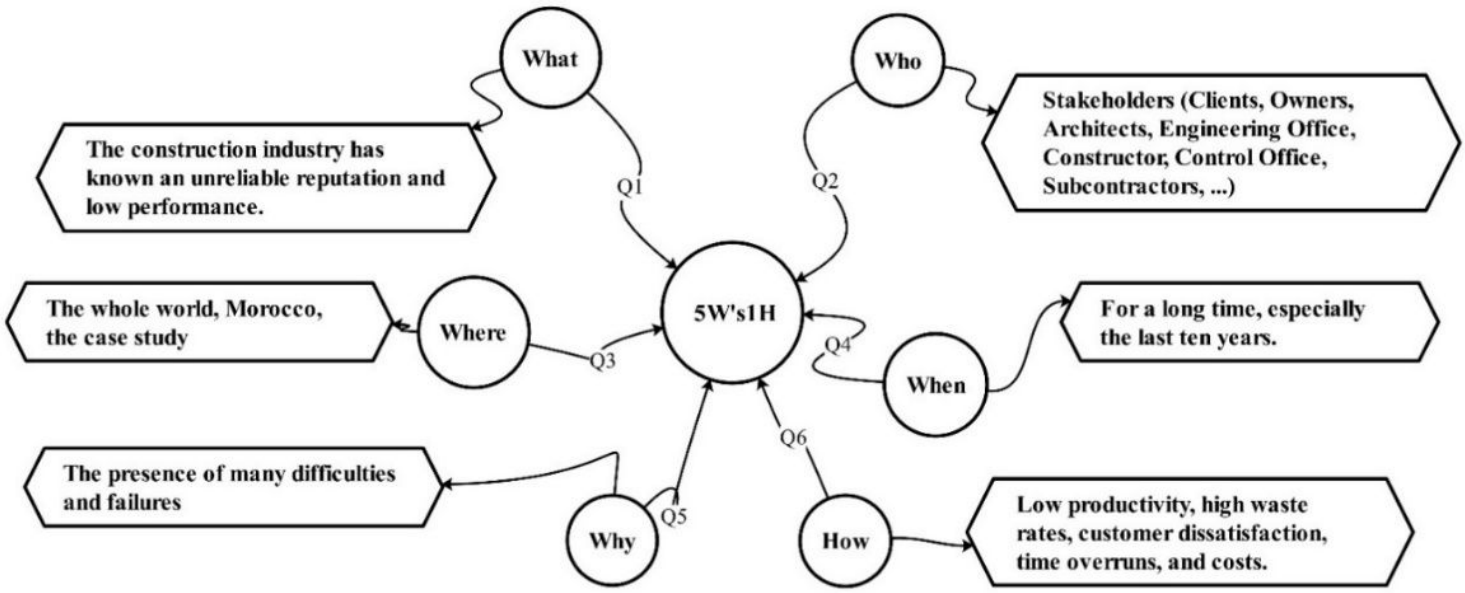



**Figure 4**

Answers to the 5W1h questions

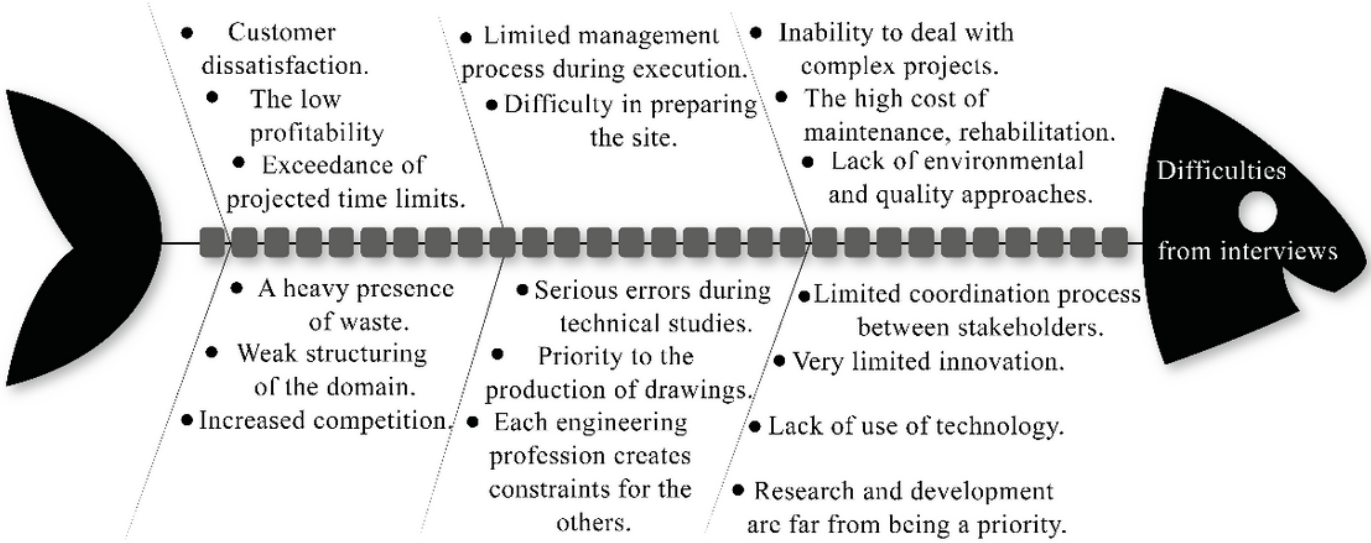



**Figure 5**

Fishbone diagram to describe difficulties from opinions of professional and academics

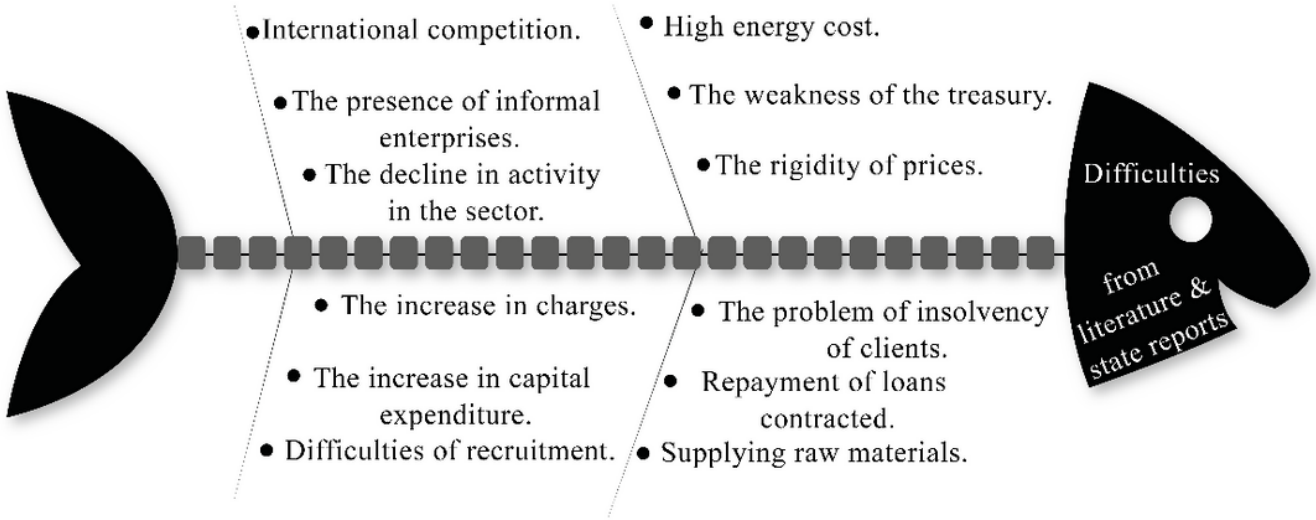
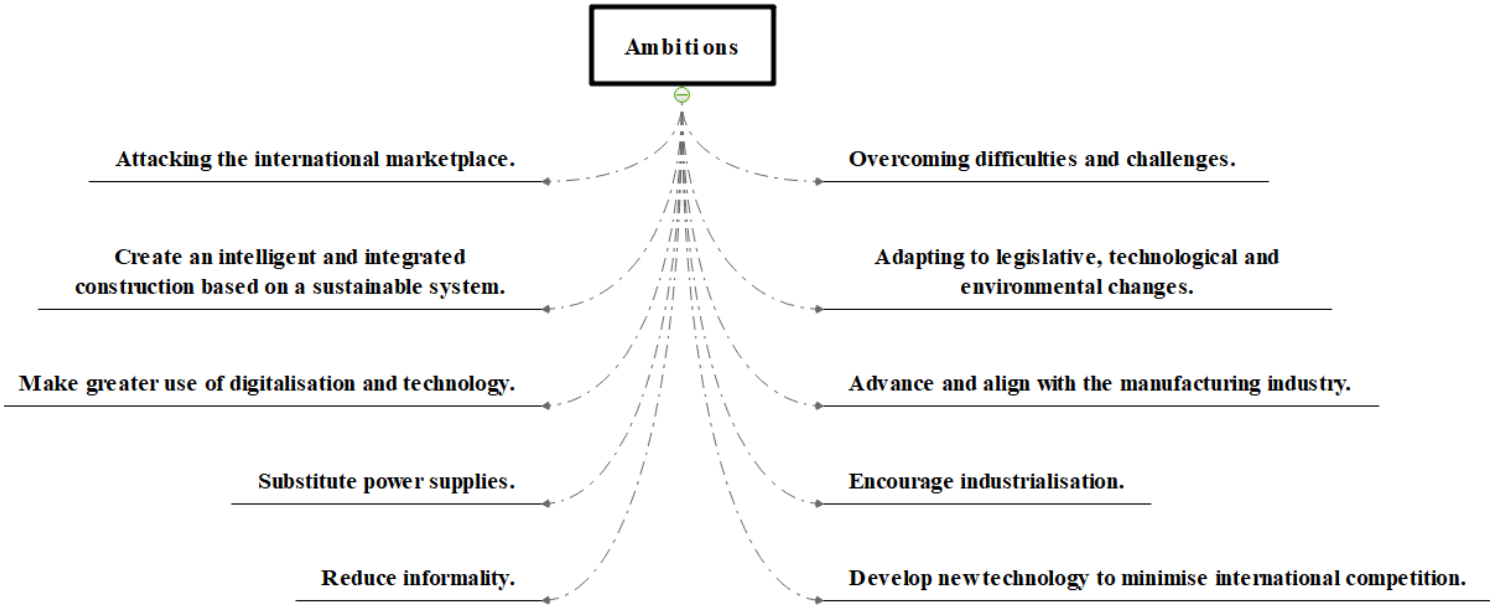



**Figure 6**

Fishbone diagram to describe difficulties from official documents and finding in the literature




## Figure 7

Ambitions of MCI