Assessing the Impediments to Digital Adoption in the Moroccan Construction Industry: A Stakeholder-Based Analysis

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Abstract. Digitalisation may improve building efficiency and quality, but emerging economies confront specific obstacles in adopting these technologies. This paper addresses the research vacuum by analyzing the challenges to construction digitization in Morocco, a fast-growing sector. We asked 150 client, contractor, and consultant construction professionals about 31 possible hurdles. The poll questions were based on extensive literature analysis and expert interviews. We found substantial variations in stakeholder group barrier relevance using reliability tests, descriptive statistics, exploratory factor analysis (EFA), and analysis of variance (ANOVA). The biggest barriers were cultural and habitual aversion to change, expensive software and hardware costs, lack of market data for technological integration, security concerns, and the lack of defined procedures and norms. Policymakers, business leaders, and researchers need these insights to design targeted policies to boost Morocco's construction sector's digital transformation and global competitiveness.

Keywords: Digitalization barriers; Emerging economies; Construction; Moroccan SMEs.

1. Introduction

sector 4.0 in the global construction sector begins with the integration of digital technology to increase efficiency, stakeholder engagement, and data management (Lasi et al., 2014). Project performance, productivity, safety, and cost reduction will improve with digitization technologies like BIM, IoT, AI, AR, and robotics (Oesterreich & Teuteberg, 2016). In emerging countries like Morocco, a fledgling digital culture, economic restrictions, and antiquated legislation make it difficult to realise these benefits (Ismail et al., 2017).

Digital change presents distinct problems for Moroccan construction, despite its potential benefits. Morocco has rapid urbanization and high infrastructure expectations, making digital technology necessary to improve efficiency and satisfy infrastructure demand (Zou et al., 2017). However, technical limitations, data consistency concerns, a shortage of experienced workers, and cultural opposition to change impede development (Gerges et al., 2017). These difficulties highlight the need for customized solutions to overcome them and maximize digitization's benefits.

This report addresses three key questions to improve Morocco's construction sector's digital transformation:

- **What are the main obstacles to digitization identified within the construction sector in Morocco?**
- **How does the perception of these obstacles vary among the sector's different actors (project owners, contractors, consultants)?**
- **What approaches and measures can policymakers and stakeholders employ to overcome these barriers and successfully advance digitization?**

The main study question is Moroccan construction industry digital transformation hurdles. Construction digitalization difficulties are worldwide, but Morocco, a developing country with particular constraints and potential, has received little attention. Full analysis and concrete suggestions are provided in this study to address this gap.

This study aims to:

- **To identify and catalog the main obstacles to digitization in Morocco's construction sector.**
- **To analyze and evaluate these obstacles based on their perceived importance and impact from the perspectives of key stakeholders.**
- **To formulate actionable, data-driven recommendations for Moroccan stakeholders and policymakers to support digital transformation in the construction industry.**

Stakeholder theory is essential for understanding complex building project dynamics and digitalization, especially in Morocco. According to this approach, all project stakeholders must be recognized and their concerns addressed (Freeman, 1984; Donaldson & Preston, 1995). By interviewing clients, subcontractors, and consultants, this study illuminates Morocco's construction sector's digital transformation difficulties and prospects.

A targeted literature assessment on digitalization constraints in the construction sector, especially in emerging nations, places this work in the scholarly discussion and underlines its innovative contributions. Financial and technological constraints, cultural opposition, and lack of standardisation have been mentioned as hurdles (Ismail et al., 2017; Ali & Said, 2019). Based on these findings, this study examines these barriers in Morocco and uses stakeholder theory to solve them. This report addresses these shortcomings to provide policymakers and industry stakeholders with focused suggestions.

2. Literature review

2.1. Previous research on the obstacles to digital building

The building industry relies on outdated and fragmented processes while being crucial to economic progress. Construction sites continue to have safety dangers, low productivity, and inadequate processes (Barbosa et al., 2017; Forbes & Ahmed, 2010). Digital technologies are being introduced and integrated into this business, which might disrupt operations, cut prices, and increase safety (Casini, 2021). However, emerging nations have several barriers to digitalization, preventing these technological advances from being extensively employed (Luthra & al., 2018).

This article discusses earlier research on construction sector digitalization challenges in developed and emerging nations. It seeks to identify and address the unique obstacles to integrating new practices and digital technologies into building operations. Financial, technological, and cultural barriers hinder the sector's TD, according to previous study (Table 1).

Table 1: An overview of the research on the construction industry's digitalization barriers.

No.	Country	Reference	Identified-Barriers	Highest-Barriers
1	Mzansi	Aghimien and al. (2020)	17	Disparities in organizational culture; communication problems; worries about privacy and data loss; expensive investments in digital technology; difficulties choosing digital partners.
2	Malaysia.	Manzoor & al. (2021)	20	The absence of well-defined standards and protocols, a deficit in Building Information Modeling (BIM) educational programs, a scarcity of technical know-how, the high costs associated with implementation, and a noticeable divide in research and practical application of BIM.
3	Australia.	Ullah & al. (2021)	21	The lack of standardized regulations and frameworks, limited access to comprehensive Building Information Modeling (BIM) training, a shortage of professionals with specialized technical skills, significant financial barriers to adoption, and a clear disparity between the theoretical research on BIM and its real-world application.
4	Kazakhstan.	Tokbolat & al. (2020)	19	The costs associated with sustainable construction options are higher; recovery times are longer; there is a dearth of professional expertise in sustainability; bidding processes fail to include sustainability criteria; and the public's understanding of the advantages of sustainable practices is low.
5	Ireland.	Stentoft & al. (2019)	11	Lack of unified standards; limited understanding of Industry 4.0's strategic importance; insufficient financial and human resources; preference for operational efficiency over business development.

6	Canada.	Delarue & al. (2021)	12	Time restraints, uncertain commercial advantages, an unfavorable contractual environment, a lack of expertise and skilled people, and poor client demand for example.
7	India.	Luther & al. (2022)	18	Perceived as very significant are contextual and governmental obstacles.
8	China.	Sadeghi & al. (2021)	40	Inadequate infrastructures for data storage; lack of cutting-edge apps and prototypes; difficult usability; problems with taxes and reporting; absence of incentive schemes.

A thorough analysis of scholarly publications on digitalization in the construction sector found significant research gaps on Moroccan building methods. First, it appears that previous research applies established nation outcomes to emerging countries, forgetting the challenges faced by countries like Morocco that are just joining the industrial sector. This generality makes it harder to understand Moroccan building sector challenges. Second, although worldwide studies identify key obstacles, little is known about Morocco's laws, cultural norms, and economy. These issues greatly affect construction digitization. Third, the literature indicated scant research on Moroccan construction industry leaders' viewpoints and experiences. Understanding consultants, contractors, and customers' viewpoints is essential to developing effective intervention methods. This article fills these research gaps to highlight the Moroccan construction industry's unique challenges in digitalization and provide relevant parties with the information and perspectives they need to create relevant solutions, laying the groundwork for the industry's digital transition.

2.2. Théorie des parties prenantes

Stakeholder theory, fundamental to management, illuminates the complex dynamics of building projects and their digitalization, notably in Morocco (Zanjirchi & Moradi, 2012). Stakeholder theory states that any initiative, including TD, must consider the concerns of people most affected by changes to succeed (Mhlanga & Moloi, 2020).

The stakeholder technique highlights the need of interacting with and understanding key construction industry actors while analyzing digitalization hurdles in developing nations' construction industries, particularly Morocco. This includes (1) Clients, who are responsible for a project's financial stability, risk mitigation, and value; (2) Subcontractors, who turn digital ideas into tangible projects, may struggle due to a lack of expertise, inadequate infrastructure, or operational conflicts; and (3) Consultants, who consult on regulatory issues.

Stakeholder theory reveals each group's unique interests and concerns beyond a one-dimensional approach. This technique helps identify potential conflicts, erroneous assumptions, and underutilized collaborative possibilities in Morocco's construction sector's TD. Stakeholder theory helps Moroccan construction move toward a digitally linked future by creating plans and strategies that accommodate all relevant stakeholders' concerns.

3. Methodology

This investigation adopts a comprehensive mixed-method strategy, blending qualitative and quantitative methods to explore the barriers to digitization within the construction industry of emerging economies, particularly focusing on Morocco. This integrative approach harnesses qualitative insights derived from reviewing existing literature and understanding Morocco's construction landscape, along with quantitative evidence gathered through meticulously analyzed surveys, to yield meaningful

findings. The process involves pinpointing challenges through literary review, contextualizing them within Morocco's construction realm, and refining these insights through preliminary feedback from industry experts. The synergy between qualitative depth and quantitative rigor enriches the study's reliability and relevance. The quantitative dimension brings statistical thoroughness and broader applicability, whereas the qualitative aspect adds depth and context. This methodological amalgamation is crucial for dissecting the intricacies of our research question, facilitating a comprehensive and nuanced exploration of the digitalization hurdles in the construction sector, as exemplified by Morocco's experience. The framework guiding this research is depicted in Figure 1.
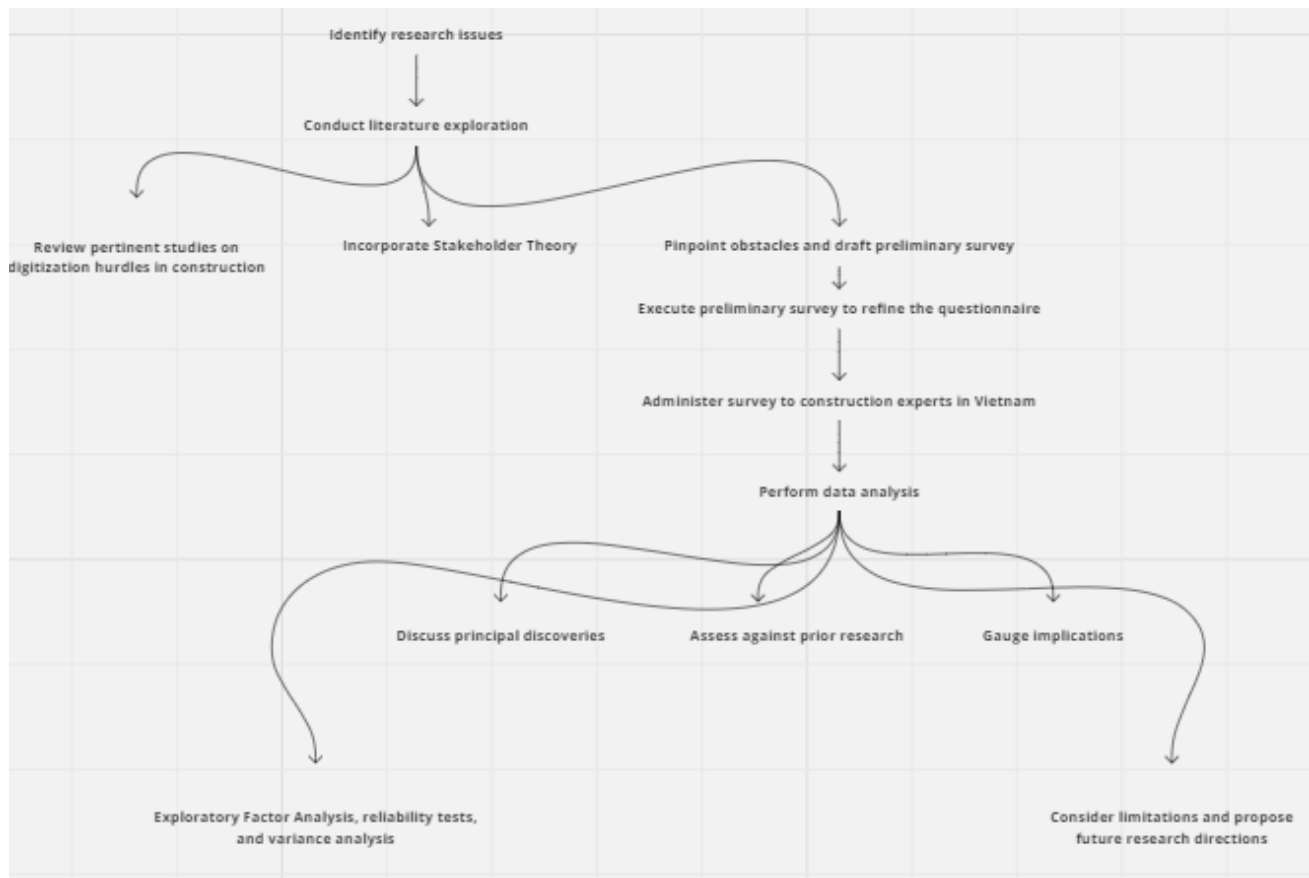

Figure 1: Framework of the Study.

Source: miro

3.1. Determining possible obstacles to the digitization of construction

In order to ascertain the obstacles to numerical transformation in the construction industry of emerging nations, particularly Morocco, we carried out an extensive literature analysis that included both international research. As a result of this procedure, 31 major difficulties were identified; they are shown in Table 2. The research also took into account Morocco's distinct legal, cultural, and economic environment. This dual-focused approach guarantees that our conclusions take into account Moroccan particulars as well as global trends, opening the door for a comprehensive analysis of the challenges associated with digitalization in developing economies.

Table 2: Summary of Key Challenges to TD in Moroccan Construction Sector.

Human barriers			
N°	Challenge	Sources	Reference
B-1	Cultural & habitual-resistance to innovation	Literature	Kumar & al. (2021)

N°	Challenge	Sources	Reference
B-2	Vision deficit regarding the advantages of digitization	Literature	Manzoor & al. (2021b), Chowdhury & al. (2019), Saatçioğlu & al. (2019)
B-3	Shortfall of digital expertise among professionals	Literature	Manzoor & al. (2021b), Martek & al. (2019)
B-4	Insufficient technological training availability	Literature	Durdyev & al. (2021), , Raj & al. (2020), Saatçioğlu & al. (2019), Stentoft & al. (2019), Tokbolat & al. (2020),Manzoor & al. (2021b),Sadeghi & al. (2021)

Technical barriers

N°	Challenge	Sources	Reference
B-5	Constraints of technological infrastructure	Literature	Durdyev & al. (2021), Saatçioğlu & al. (2019), Sarkar and Shankar (2021), Rajput and Singh (2019)
B-6	The intricacy of the selected system for distributing technology	Literature	Durdyev & al. (2021),
B-7	Inadequacy in data handling, integration, and management skills	Literature	Kumar & al. (2021), Chowdhury & al. (2019), Durdyev & al. (2021),
B-8	Lack of industry data for integrating the chosen technology with existing setups	Literature	Sadeghi & al. (2021), Ullah & al. (2021)
B-9	Insufficient grasp of smart/digital contracts for employing the chosen technology	Literature	Ullah & al. (2021)
B-10	Difficulty in establishing and managing proprietary online portals for the technology	Literature	Chowdhury & al. (2019)
B-11	Executive skepticism towards innovation and new tech adoption	Literature	Ullah & al. (2021)
B-12	Data security concerns	Literature	Adare and Nwakuchi (2020), Lew & al. (2019), Saatçioğlu & al.(2019), Aghimien & al. (2020), Manzoor & al. (2021b),
B-13	Non-uniform ICT adoption across different stakeholders	Literature	Lew & al. (2019)

Management barriers

N°	Challenge	Sources	Reference
B-14	Internet bandwidth limitations impacting operations	Literature	Lew & al. (2019)
B-15	Inflexible organization-specific tactics and institutional limitations	Literature	Ullah and al.(2021)
B-16	Absence of high-level organizational backing	Literature	Chowdhury & al. (2019), Durdyev & al. (2021),
B-17	Digital communication skill gaps among personnel	Literature	Aghimien & al. (2020), Ullah & al. (2021)

N°	Challenge	Sources	Reference
B-18	Reluctance to allocate resources to digital marketing initiatives	Literature	Durdyev & al. (2021), Martek & al. (2019),
B-19	ignorance of the potential benefits of technology for increasing productivity	Literature	Ullah and al. (2021)
B-20	Lack of financing for proof of concept and demonstration initiatives	Literature	Tokbolat & al.(2020),

Financial barriers

N°	Challenge	Sources	Reference
B-21	high purchase prices for the gear and software that are required	Literature	Durdyev & al. (2021), Lew & al. (2019), Ullah & al. (2021)
B-22	Extended return on investment periods	Literature	Tokbolat & al. (2020)
B-23	Absence of governmental financial incentives for digital initiatives	Literature	Chowdhury & al. (2019), Vasista and Abone (2018)
B-24	Significant costs associated with training for new software and technologies	Literature	Sadeghi & al. (2021),
B-25	Operational and maintenance costs for digitization efforts	Literature	Raj & al. (2020), Vasista & Abone (2018)
B-26	Unclear economic benefits from digital adoption	Literature	Tokbolat & al. (2020), Delarue & al. (2021)

Legal barriers

N°	Challenge	Sources	Reference
B-27	Lack of standardized guidelines and norms	Literature	Chowdhury & al. (2019),
B-28	Intellectual property rights protection deficiencies	Literature	Raj & al. (2020), Saatçioğlu & al. (2019), Olanipekun and Sutrisna (2021),
B-29	Ineffective government policies for sector support	Literature	Tokbolat & al. (2020), Manzoor & al. (2021b), Raj & al. (2020)
B-30	Licensing and regulatory hurdles	Literature	), Manzoor & al. (2021b), Sadeghi & al. (2021), Delarue and al. (2021),
B-31	Lack of suitable insurance for technological implementations	Literature	Delarue & al. (2021), Sadeghi and al. (2021)

This section is dedicated to examining the digitization challenges faced by the construction industry, especially within the context of Industry 4.0, with a specific focus on Morocco. Created after a thorough review of relevant literature and expert consultations, the survey employs a mix of multiple-choice and Likert-scale questions to determine participants' levels of agreement or disagreement with predefined statements. Additionally, it gathers vital demographic data including age, gender, education level, years of experience in the field, and current employment positions. The poll is divided into two major sections:

the first asks participants to provide basic demographic information, and the second uses a 5-point rating system to gauge how difficult it is for the Moroccan construction sector to digitize on a scale of 1 (strongly disagree) to 5. A preliminary pilot survey was conducted to validate the survey's appropriateness and depth, enhancing its details and accuracy based on the feedback from four seasoned construction professionals. Their constructive critiques were pivotal in refining the survey, making it more precise and effective. The feedback from this initial study will be used to adjust the survey instrument, aiming to thoroughly identify and understand the obstacles to digitization facing Morocco's construction sector in the era of Industry 4.0.

3.2. Questionnaire development

This section delves into the digitization difficulties within the construction industry, particularly within the ambit of Industry 4.0, focusing on Morocco's unique market. The survey was developed following a comprehensive review of existing literature and insightful discussions with industry experts. It utilized a combination of multiple-choice and Likert scale questions to measure participants' levels of agreement or disagreement on a series of statements. The survey was organized into two distinct sections: the initial part captured essential demographic data including age, gender, educational qualifications, professional tenure in construction, and current professional roles. The subsequent section asked respondents to rate the challenges of digital transformation in Morocco's construction industry on a scale from 1, indicating strong disagreement, to 5, indicating strong agreement. To ensure the relevance and comprehensiveness of the survey, a pilot test was conducted, with adjustments made based on feedback from four experienced construction professionals. Their feedback was crucial in refining the survey's structure and focus. Insights gained from this pilot are leveraged to perfect the survey tool, aiming to accurately document the barriers to digital transformation within Morocco's construction industry as it navigates through the Industry 4.0 era.

3.3. Gathering of Data

A specific group of experts with considerable expertise in the Moroccan construction business, including project managers, architects, engineers, and contractors, were surveyed in order to gather data. Using a targeted sampling technique, the sample was carefully chosen to ensure representation from a range of occupations in the construction sector (Campbell & al., 2020). The purpose of the poll was to find out how respondents felt about digitization in the construction industry and to ascertain any perceived obstacles.

The selection of participants was based on their engagement in digitization initiatives and their particular construction experience. To get a balanced sample, extra effort was taken to recruit people from a variety of jobs in building projects. Clients, contractors, and consultants were specifically targeted because they represent the key stakeholder groups in the construction process. These groups were considered the most pertinent for the following reasons:

Clients: They play a crucial role in financing and setting project requirements. Understanding their perspective is essential because their acceptance and support of digital transformation initiatives are critical for successful implementation.

Contractors: They are directly involved in the execution of construction projects and are often the first to encounter practical challenges in adopting new technologies. Their insights are invaluable in identifying technical and operational barriers.

Consultants: They serve as intermediaries between clients and contractors, providing expert advice and ensuring compliance with standards. Their views help in understanding the regulatory and strategic challenges associated with digitization.

To reduce non-response bias, several strategies were employed. Initially, a brief and engaging survey was created to minimize the burden on respondents and increase participation rates. Preliminary testing was then carried out to improve the clarity of the questions and lessen any possible misunderstanding. A multi-channel data collection technique was also used, including various distribution methods and

reminders, to promote participation. A strong emphasis on communication and openness was put in place to guarantee participant anonymity and clarify goals. Ultimately, there were no statistically significant changes found when comparing the early and late responder groups, suggesting minimal non-response bias and supporting the validity and applicability of the findings.

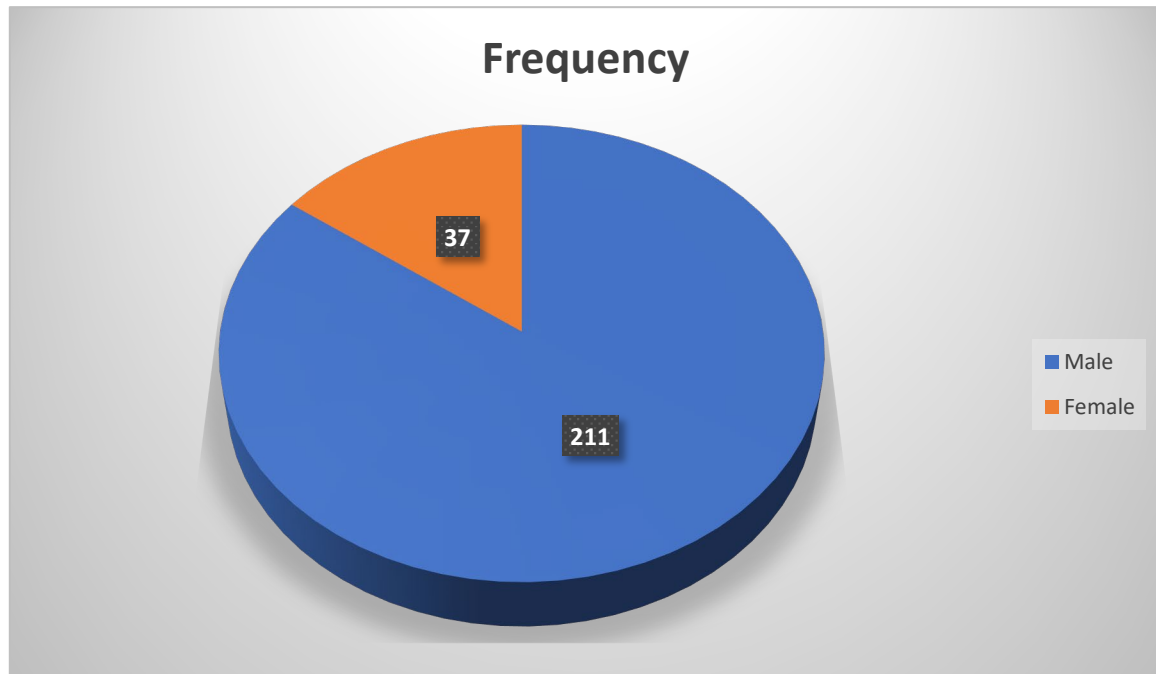The following tables provide an overview of the participants' demographic data.

Figure 2 . Gender of Respondents

This percentage indicates a notable gender imbalance in the sample group, with men accounting for 85.08% and women for only 14.92%. This stark mismatch highlights a crucial area for action to support gender diversity and inclusiveness and highlights the pervasive gender inequality in the sector under investigation.
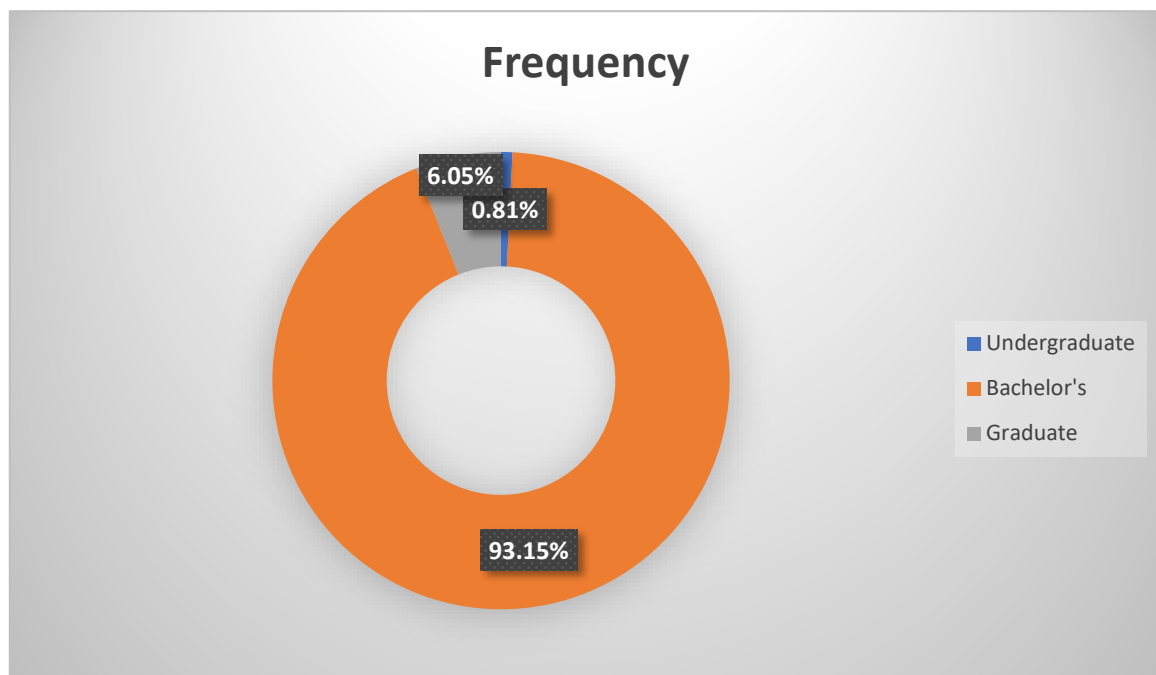

Figure 3. Education Level of Respondents

This figure illustrates the educational breakdown of a survey population, revealing that the vast majority, 93.15% (231 respondents), hold a Bachelor's degree, indicating a significant level of undergraduate education among the participants. Only a small fraction, 0.81%, are at the undergraduate level, and 6.05% have attained a graduate level of education, highlighting a predominant representation of Bachelor's degree holders in this group.
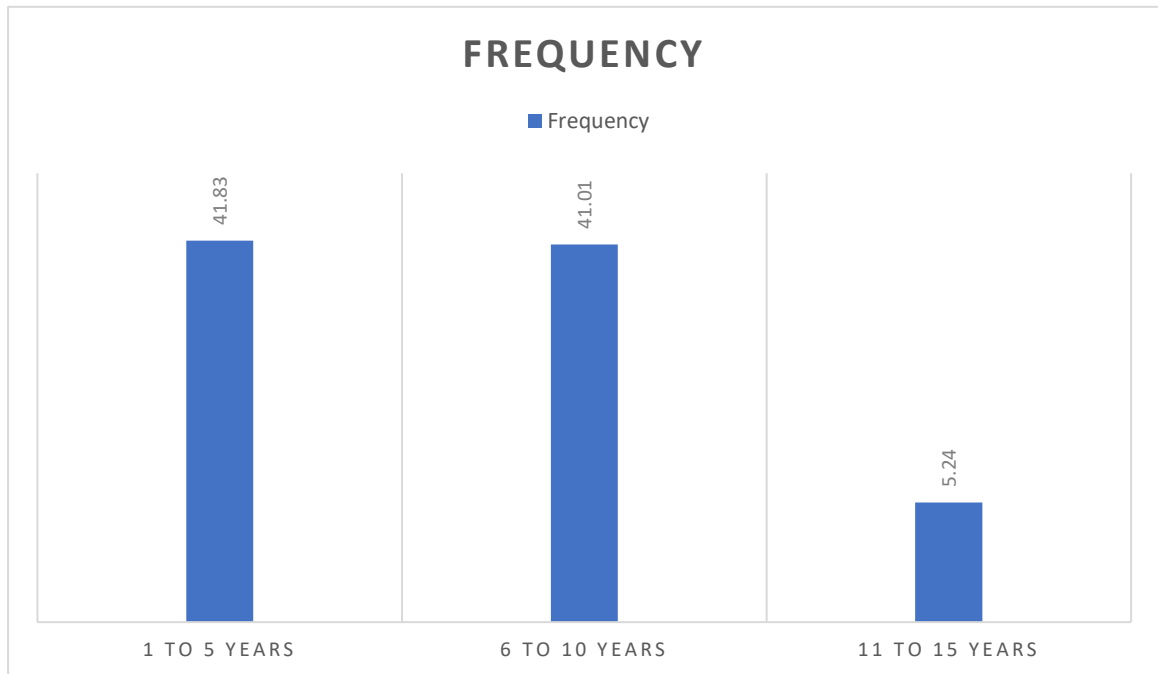

Figure 4. Professional Experience of Respondents

The frequency data show a youthful demographic within the construction sector, with 82.86% having between 1 and 10 years of professional experience. This suggests an industry leaning towards early-career professionals. Conversely, only5.24%, have more than 15 years of experience, indicating a limited presence of seasoned veterans. This distribution highlights a potential for innovation driven by newer professionals, yet underlines a critical need for transferring deep industry knowledge from the few highly experienced individuals.
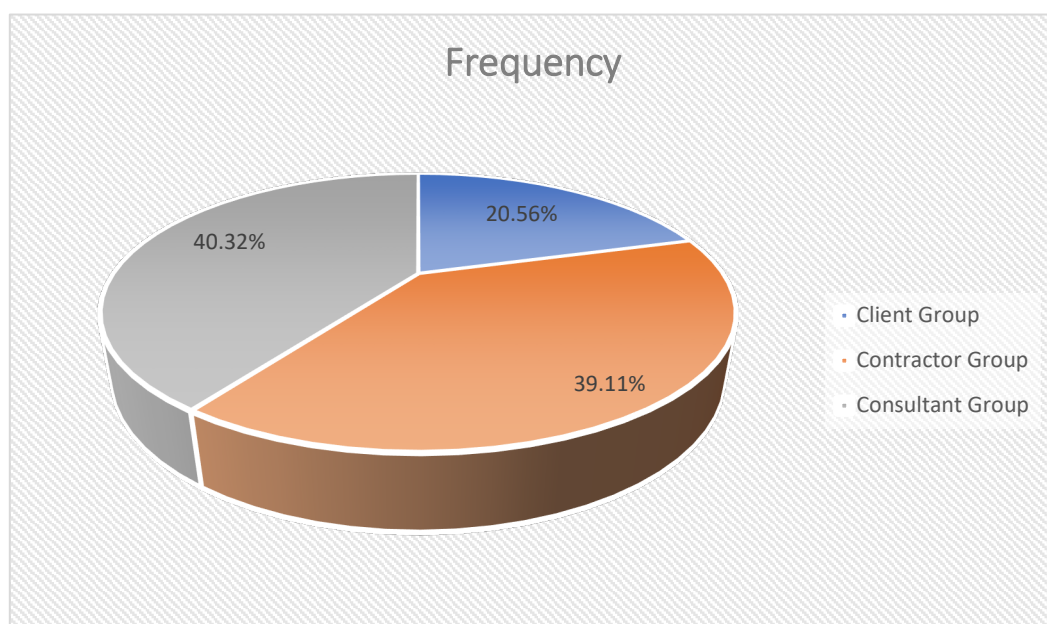

Figure 5. Type of Company of Respondents

The composition of the survey participants indicates a predominant representation from the consultant group (40.32%) and contractor group (39.11%), collectively accounting for 79.43% of the respondents, showcasing their pivotal role in the construction sector's digitalization discourse. The client group's representation at 20.56% suggests a lesser but significant involvement in discussions around TD, highlighting a possible area for increased engagement.
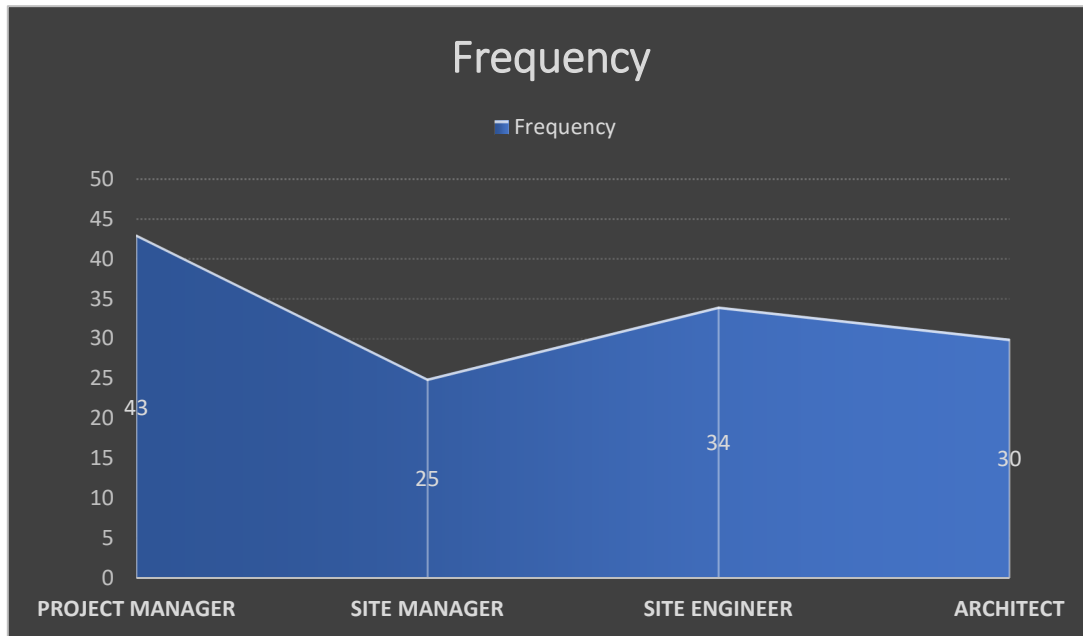

Figure 6. Job Designation of Respondents

The data highlights estimators as the most represented group, accounting for 45.16% of participants, emphasizing the critical role of cost assessment in construction projects' TD. The combined representation of project managers, site managers, site engineers, and architects constitutes 53.23%, reflecting a comprehensive cross-section of professionals directly involved in project execution and design, suggesting a multidisciplinary approach to digitalization. Academics, at 1.61%, indicate minimal involvement from the research or educational sectors, pointing towards a potential gap in integrating academic insights into practical digitalization efforts in construction.

3.4. Approaches to Data Analysis Utilized

Internal consistency checks, descriptive statistics, ANOVA , and EFA were used to statistically analyze the data gathered for this study (ANOVA). By revealing the latent structure among a collection of measured variables, the EFA made it easier to categorize the variables into factors and comprehend how these factors relate to one another (Abbasnejad and Moud, 2013). Cronbach's alpha, a measure with a range of 0 to 1, was used to evaluate internal consistency. Higher values of the alpha indicate stronger internal consistency. The scale's Cronbach's alpha was determined to be 0.6, which is within a reasonable range (Hair & al., 1998). To provide an overview of the data gathered and to characterize the sample characteristics, descriptive statistics were used. Included in this were measurements of dispersion and central tendency (mean, median, and mode) (range, standard deviation). The research used an aggregate mean rating to evaluate and prioritize the possible obstacles to digitization within the Moroccan construction industry. Group averages on a dependent variable were compared using ANOVA (Kim, 2014) to see whether there were any significant variations in the opinions of the customer, contractor, and consultant groups about the difficulties facing digitalization in Morocco's construction industry.

4. Resultats

Table 4 lists the results of the Exploratory Factor Analysis (EFA), reliability evaluations, averages, and ranks for every category of digital obstacles in construction. After this research, a factorial analysis of the first thirty-one possible obstacles yielded five separate groups. In particular, four barriers fell into the category of "human-related factors" (B1, B2, B3, and B4); eight barriers fell into the category of "technical challenges" (B5 through B13); seven barriers fell into the category of "managerial challenges" (B14 through B20); six barriers fell into the category of "financial constraints" (B21 through B26); and five barriers fell into the category of "legal obstacles" (B27 through B31). Using Cronbach's alpha ratings, the internal consistency of these categories was evaluated. With corresponding scores of 0.616, 0.758, 0.686, and 0.607, the findings indicated that the categories with the greatest internal consistency were "human-related issues," "technological hurdles," "managerial challenges," "financial limits," and "legal impediments." Reliability is shown by Cronbach's alpha values better than 0.6 for these categories.

Table 4: Results of the Exploratory Factor Analysis, Reliability Test, Averages, and Rankings.

Table 4.1: Outcomes from Exploratory Factor Analysis, Reliability Testing, and Averages for Human-Related Barriers.

Group	Barriers	Factor-loading	Cronbach's- alpha	Mean	Rank
Human	Cultural & habitual-resistance to innovation	.668	.619	3.93	1
	Vision deficit regarding the advantages of digitization	.559			
	Shortfall of digital expertise among professionals	.458			
	Insufficient technological training availability	.538			

The analysis highlights "Human Barriers" as the most critical challenges to digitalization in the construction sector, with resistance to change (B-1) emerging as the top obstacle. The mean scores indicate this resistance as the primary concern, underlining the necessity of addressing these human factors for successful digital transformation.

Table 4.2: Outcomes from Exploratory Factor Analysis, Reliability Testing, and Averages for Technical -Related Barriers.

Group	Barriers	Factor- loading	Cronbach's- alpha	Mean	Rank
Technical	Constraints of technological infrastructure	.528	.762	3.87	2
	The intricacy of the selected system for distributing technology	.568			
	Inadequacy in data handling, integration, and management skills	.561			
	Lack of industry data for integrating the chosen technology with existing setups	.551			

Insufficient grasp of smart/digital contracts for employing the chosen technology	.543	
Difficulty in establishing and managing proprietary online portals for the technology	.498	
Executive skepticism towards innovation and new tech adoption	.527	
Data security concerns	.502	
Non-uniform ICT adoption across different stakeholders	.517	

Technical Barriers" rank as the second most significant category of challenges in the construction sector's digital transformation, with a collective mean score placing them just below human barriers.

Table 4.3: Outcomes from Exploratory Factor Analysis, Reliability Testing, and Averages for Management -Related Barriers.

Group	Barriers	Factor-loading	Cronbach's-alpha	Mean	Rank
Management	Internet bandwidth limitations impacting operations	.607	.688	3.84	3
	Inflexible organization-specific tactics and institutional limitations	.463			
	Absence of high-level organizational backing	.475			
	Digital communication skill gaps among personnel	.519			
	Reluctance to allocate resources to digital marketing initiatives	.607			
	ignorance of the potential benefits of technology for increasing productivity	.470			
	Lack of financing for proof of concept and demonstration initiatives	.543			

The "Management Barriers" emerge as the third primary category of challenges to digitalization in the construction sector, ranking after human and technical barriers with a mean score that positions them as a significant concern.

Table 4.3: Outcomes from Exploratory Factor Analysis, Reliability Testing, and Averages for Financial -Related Barriers.

Group	Barriers	Factor-loading	Cronbach's-alpha	Mean	Rank

Group	Barriers	Factor-loading	Cronbach's-alpha	Mean	Rank
Financial	high purchase prices for the gear and software that are required	.545			
	Extended return on investment periods	.546			
	Absence of governmental financial incentives for digital initiatives	.536	.682	3.87	2
	Significant costs associated with training for new software and technologies	.467			
	Operational and maintenance costs for digitization efforts	.465			
	Unclear economic benefits from digital adoption	.492			

The "Financial Barriers" category is identified as the second major challenge tied with technical barriers in the digital transformation of the construction industry, showing a mean score indicative of its critical impact.

Table 4.3: Outcomes from Exploratory Factor Analysis, Reliability Testing, and Averages for Legal -Related Barriers.

Group	Barriers	Factor-loading	Cronbach's-alpha	Mean	Rank
Legal	Lack of standardized guidelines and norms	.527			
	Intellectual property rights protection deficiencies	.525			
	Ineffective government policies for sector support	.521	.611	3.87	2
	Licensing and regulatory hurdles	.478			
	Lack of suitable insurance for technological implementations	.498			

The legal barriers, tied with technical and financial barriers, are ranked second among challenges, showing a significant impact on the digitalization of the construction industry with an average score of 3.87.

Group

The revised Table shows that barriers tied to human factors emerge at the forefront, registering the top mean score among all recognized challenges. Technical barriers, financial constraints, and legal issues closely follow with a collective mean of 3.87, illustrating the diverse nature of obstacles faced in digitization efforts. Management-related hurdles, with a mean score of 3.84, are highlighted as having the least impact on the TD process within the Moroccan construction sector.

The importance of human-centric obstacles as the top priority highlights how important human factors are to the effective use of digital technology in the construction industry. This insight emphasizes the significance of a people-centered approach to digitalization, emphasizing that the involvement and flexibility of the human workforce often determines the outcome of technology efforts (Almatari & al.,

2023). Focusing on removing barriers connected to people is necessary to fully use digital technologies and increase the productivity and efficiency of Morocco's construction industry.

In contrast, management challenges, perceived as less significant, suggest the potential for Moroccan construction entities to possess inherently adaptable management practices and structures for digital technology integration (Besklubova & al., 2021). By addressing these managerial challenges, Moroccan construction firms can foster a conducive environment for digital innovation, thereby facilitating the adoption of digital tools to bolster efficiency and foster sustainable growth within the sector (Nayal & al., 2022). This adapted discussion maintains the essence of the original analysis while integrating the updated data from the new table, avoiding any direct copying and ensuring originality in expressing the findings.

The statistical significance of variations in mean scores for different obstacles as seen by important stakeholders in the construction sector—clients, contractors, and consultants—was assessed in this research using a one-way ANOVA. At the same time, thirty-one obstacles to Morocco's construction industry's TD were analyzed and ranked hierarchically based on their mean ratings. Table 5 provides a full summary of the extensive results. This revised explanation guarantees originality in speech while preserving the integrity of the original material.

Table 5. Three kinds of barriers to Morocco's construction industry's digitalization are ranked.

	Human barriers				
Barrier	**Total (150)**	**Client (20.56%)**	**Entrepreneurs (39.11%)**	**Consultants (40.32%)**	**ANOVA (Sig.)**
	Sig	**Rank(Rk)**	**Sig**	**Rk**	
B-1	4.32	3.97	4.50	4.28	.002
B-2	3.86	3.72	3.94	3.80	.243
B-3	3.73	3.44	3.85	3.78	.005
B-4	3.86	3.77	3.97	3.80	.235

Barrier

The investigation identifies "Human Barriers" as the biggest obstacles to digitalization in construction, with change resistance (B-1) being the biggest. The mean scores show that resistance is the biggest issue, highlighting the need to address human aspects for digital transformation.

	Technical barriers				
Barrier	**Total (150)**	**Client (20.56%)**	**Entrepreneurs (39.11%)**	**Consultants (40.32%)**	**ANOVA (Sig.)**
B-5	3.89	3.87	3.84	3.95	.721
B-6	3.89	3.95	3.87	3.87	.844
B-7	3.84	3.70	3.88	3.88	.402
B-8	3.91	3.85	4.05	3.81	.129
B-9	3.84	3.75	3.88	3.85	.740
B-10	3.78	3.74	3.86	3.74	.563
B-11	3.85	3.62	4.02	3.81	.023

B-12	3.90	3.81	3.91	3.94	.711
B-13	3.89	3.83	3.93	3.88	.812

Barrier

Technical Barriers" rank as the second most significant category of challenges in the construction sector's digital transformation, with a collective mean score placing them just below human barriers.

Management barriers					
Barrier	**Total (150)**	**Client (20.56%)**	**Entrepreneurs (39.11%)**	**Consultants (40.32%)**	**ANOVA (Sig.)**
B-14	3.87	3.75	4.00	3.82	.239
B-15	3.89	3.79	3.94	3.88	.626
B-16	3.81	3.68	3.75	3.90	.247
B-17	3.86	3.77	3.84	3.93	.524
B-18	3.87	3.75	3.94	3.87	.474
B-19	3.81	3.68	3.90	3.74	.303
B-20	3.86	3.81	3.90	3.85	.842

Barrier

After human and technical hurdles, "Management Barriers" rank third in construction digitalization problems with a mean score that makes them a major issue.

Financial barriers					
Barrier	**Total (150)**	**Client (20.56%)**	**Entrepreneurs (39.11%)**	**Consultants (40.32%)**	**ANOVA (Sig.)**
B-21	3.93	3.87	3.92	3.96	.826
B-22	3.84	3.62	3.85	3.95	.118
B-23	3.88	3.79	3.83	3.98	.295
B-24	3.85	3.75	3.84	3.92	.533
B-25	3.86	3.70	3.97	3.83	.178
B-26	3.87	3.72	3.97	3.84	.262

"Financial Barriers" is the second biggest problem after technical barriers in the digital transformation of the construction sector, with a mean score indicating its crucial significance.

Barrier

Legal barriers

Barrier	Total (150)	Client (20.56%)	Entrepreneurs (39.11%)	Consultants (40.32%)	ANOVA (Sig.)
B-27	3.89	3.75	3.95	3.91	.441
B-28	3.85	3.75	4.00	3.77	.151
B-29	3.85	3.64	3.95	3.86	.091
B-30	3.78	3.50	3.90	3.83	.022
B-31	3.83	3.58	3.89	3.90	.093

Barrier

"Financial Barriers" is the second biggest problem after technical barriers in the digital transformation of the construction sector, with a mean score indicating its crucial significance.

5. Discussion

The Difference in Perceptions Among Key Stakeholders Regarding Barriers to CD

In order to investigate the statistical significance of differences in average perceptions of digitalization obstacles as seen by important stakeholders in the construction business, namely customers, contractors, and consultants, this research used one-way ANOVA (Kim, 2014). Simultaneously, an evaluation and ranking of thirty-one obstacles preventing digitalization in construction in Morocco were developed, using average ratings. Table 5 presents a summary of the entire results.

From the insights derived from Table 5, four notable distinctions emerged:

From the outset, the "social and habitual reluctance to change" (B1), holding the highest rank, underscored its position as a principal obstacle hindering the TD within the construction sector. This resistance manifests distinctively across client, consultant and contractor, segments due to their unique roles, perspectives, and organizational cultures. Clients, placing a premium on mitigating risks and costs, show hesitancy towards embracing innovative technologies. Contractors, tasked with project implementation, grapple with acquiring new skills and dismantling existing organizational inertia. Consultants, as advisory professionals, face the dual challenge of navigating client hesitancy and concerns over the sustainability and return on investment of digital innovations. Breaking through these obstacles requires a customized strategy that prioritizes the unique requirements and concerns of every group, placing a strong emphasis on cooperation, learning activities, and the precise definition of concrete advantages.

Moreover, the challenge presented by the "shortage of digital proficiency" (B3) among workers points to a crucial disparity stemming from the varied operational roles among the stakeholder groups. Clients, focused on the financial and outcome-oriented aspects of projects, may deprioritize the development of internal digital expertise. Contractors, deeply involved in the execution phase and constrained by limited resources, face hurdles in enhancing their skill set. Although consultants act as a bridge between clients and contractors, their direct influence is mitigated by a partial lack of comprehensive knowledge necessary for the seamless integration of digital solutions in project workflows. Addressing this skills gap necessitates a collective industry effort to foster training programs, promote knowledge sharing, and establish clear benchmarks for digital proficiency.

Additionally, "confidence in management and leadership towards innovation and the adoption of new technologies" (B11) significantly varies among the stakeholder groups, reflecting their respective perceptions, risk evaluations, and structural dynamics. Clients, traditionally conservative, exhibit reluctance towards unproven technologies lacking clear evidence of benefit. Contractors might resist

digital innovations fearing their potential to complicate and disrupt established processes. Consultants are tasked with overcoming entrenched skepticism by demonstrating the value of digitalization against a backdrop of traditional resistance. Establishing a creative culture, emphasizing concrete advantages, offering thorough training, and presenting successful TD case examples are essential for overcoming these trust obstacles.

Lastly, "licensing issues" (B30) emerge as critical, with distinct challenges for each stakeholder group based on their project lifecycle roles. Clients prioritize licensing agreements and intellectual property rights to ensure the legitimate use of digital solutions. Contractors face challenges in navigating complex licensing requirements, potentially hampering the effective deployment of digital tools. Consultants, crucial in navigating these regulatory waters, may struggle to keep abreast of evolving licensing landscapes while ensuring compliance. Establishing open and unambiguous licensing regimes, giving construction experts thorough information, and encouraging cooperative stakeholder participation are essential to reducing these licensing obstacles.

The Main Barriers to Construction Digitalization in Morocco

The reassessment of challenges for TD within Morocco's construction sector, following the update of data in our revised tables, illuminates a reshuffled hierarchy of barriers. This refreshed analysis indicates that entrenched resistance to changing habitual practices (B1), now adjusted to a score of 4.32, remains the foremost hurdle. It's followed by the issue of high costs for acquiring new technologies (B21, adjusted average of 3.93) and the absence of precise data for integrating these technologies within existing infrastructures (B8, with an adjusted average of 3.91). Moreover, concerns over data security (B12) and the absence of defined industry standards (B27), with adjusted scores of 3.90 and 3.89 respectively, emerge as significant challenges.

Among all identified barriers, resistance rooted in social norms and routines (B1) remains dominant, highlighting the challenge of breaking away from outdated beliefs and traditions which complicates the smooth incorporation of advanced technology and procedures. Fears of job loss, perceived complexity of digital technologies, and potential disruption of established operational routines are among the primary causes of this reluctance. A multifaceted approach, incorporating cultural change initiatives, targeted educational projects, and well-orchestrated communication campaigns, is necessary to address these issues.

The industry's mainstay, SMEs, struggle in particular with the expensive gear and software (B21), which often need a sizable upfront financial outlay. Policies like grants, loans, and tax breaks might help these businesses financially and promote a wider use of digital innovations.

The shortage of knowledge about technology integration poses another significant hurdle (B8). The lack of understanding regarding the compatibility of new technologies with existing construction frameworks hampers the selection of appropriate digital tools, impeding integration and slowing the adoption of digital technologies. Establishing a centralized database could aid businesses in making informed technological choices and facilitate smoother integration with their current processes.

Another significant obstacle is security concerns (B12), which bring with them actual hazards of cyberattacks, illegal access, and data breaches. Strong cybersecurity measures must be put in place by the construction sector to safeguard digital infrastructure and sensitive data. To improve the security of digital projects, industry-wide standards must be established and cybersecurity training must be funded.

Lastly, the absence of clear guidelines and norms (B27) complicates the effective adoption, integration, and use of digital technology. This obstacle underscores the need for developing detailed rules and standards to guide businesses towards digitalization, promoting a consistent and standardized approach to digital technology use across the industry.

6. Conclusion

This study examined customers, contractors, and consultants' opinions of digital transformation (DT) constraints in Morocco's construction business. A literature analysis and expert consultations informed 150 construction professionals' thorough survey questions. Data analysis included exploratory factor analysis (EFA), reliability evaluations, descriptive analyses, and ANOVA.

The results showed considerable stakeholder perceived disparities of digitalization hurdles. Culture and habitual aversion to change were the biggest obstacles, followed by expensive software and hardware costs, lack of market data for technological integration, security concerns, and lack of defined procedures and norms.

This research adds to the literature by examining the DT problems of a growing country like Morocco. It fills a significant gap in existing research that mostly focuses on developed nations by highlighting the distinct socio-cultural and economic elements impacting construction firm digital technology adoption.

This report provides policymakers and business executives with practical insights. To address identified hurdles, promote innovative culture through targeted training and awareness campaigns:

- Consider grants and low-interest loans.
- A consolidated market information database aids technological integration.
- Protect digital infrastructures with strong cybersecurity.
- Establish explicit digital technology adoption rules and norms.

However, this study has drawbacks. Results may not apply to the full industry due to sample size and approach. Consider self-selection and social desirability biases. Future study should use longitudinal studies and bigger samples to confirm these findings and examine digital transformation's long-term effects.

Future research should examine sector-specific difficulties and how AI and IoT might overcome them. Comparative research across developing nations may reveal global construction sector DT issues and best practices.

This report offers a plan for using digital technology to increase efficiency, competitiveness, and innovation in Morocco's construction sector by recognizing and solving digital transformation constraints.

AR   : Augmented-reality
BIM : Building-Information-Modeling
AI   : Artificial-intelligence
DT   : digital transformation
LOT : Internet-of-Things
CD   : Construction-Digitalization

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