Core Requirements for Developing a Successful BIM Execution Plan in Yemen: A Quantitative Study

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***Abstract*—** Building Information Modelling (BIM) is a disruptive technology that has the ability to greatly improve the efficiency and effectiveness of construction projects. However, its implementation in impoverished nations like Yemen is hampered by significant barriers, most notably a lack of a defined and contextualised implementation plan. This study fills a major need by identifying and prioritising the key elements for creating a successful BIM Execution Plan (BEP) specific to the Yemeni environment. A structured questionnaire was distributed to a targeted sample of 56 specialists, including academics (30.4%), project managers (23.2%), and consultants/engineers (46.4%).Because of the scarcity of professionals with prior experience in the technology, the snowball sampling technique was used to pick the sample. The study indicated that BIM adoption in Yemen remains in its early stages. It successfully identified 10 major implementation needs and analysed their possibility, with experts citing defining BIM objectives, forming the implementation team and defining BIM utilisation as the most crucial precondition for effective adoption. This study provides a tested, prioritised checklist that will serve as a core roadmap for Yemeni construction enterprises. By concentrating on these critical first steps, businesses may streamline the implementation process and efficiently overcome the initial barriers to BIM adoption.

***Keywords*—** Building Information Modeling (BIM), BIM Execution Plan (BEP), Quantitative Analysis, Implementation Requirements, Yemen Construction Industry (YCI).

I. INTRODUCTION

The global architectural, engineering, and construction (AEC) sector is undergoing a significant digital change[1, 2], with Building Information Modeling (BIM) leading the way[3]. As a process centered on the creation and management of an intelligent information model, BIM has demonstrated its ability to alleviate many of the industry's chronic ailments, such as poor coordination and design errors, which frequently jeopardize project success during the critical planning and design stages[4] . However, the move from prospective benefits to real achievements is not automatic; it requires a systematic and strategic implementation.

The BIM Execution Plan (BEP) is the foundation of all successful BIM implementations [5]. The BEP is far more than just a technical document; Rather, it represents best practices for effective information management. It acts as the project's strategic constitution, including the objectives, responsibilities, and techniques for implementing BIM. It defines the scope of BIM use, establishes information exchange standards, explains needed deliverables, and outlines methods for cooperation, quality control, standardization, and information flow, among other best practices. This avoids the pandemonium that can result from uncoordinated digital activities[6-11]. Without a strong BEP, BIM adoption efforts sometimes deteriorate into unorganized, inefficient procedures that fail to meet their promises[12, 13].

This study is thus based on the assumption that a successful BEP is the direct result of meeting a set of defined basic conditions. This research attempts to bridge the practical gap by defining and analyzing the fundamental elements for building a successful BIM Execution Plan, suited to the specific difficulties and opportunities within the Yemeni construction sector

The scholarly debate on BIM in Yemen, however sparse, paints a clear image of an industry at a crossroads. Foundational early investigations, such as [14]successfully diagnosed the initial landscape, revealing low awareness levels and major barriers to BIM deployment. This emphasis on barriers and influential factors was expanded upon by Al-[15]), strengthening a knowledge of the challenges confronting the Yemeni building industry. The discourse also extended to identifying Critical Success Factors (CSFs) for implementing modern technologies like BIM in the Yemeni context[16, 17].

While these studies were useful in determining the "why" and "why not" of BIM adoption, they have mostly remained diagnostic in nature. However, the landscape is changing; with professionals becoming more aware of the importance of BIM, the emergence of specialized training centers, and preliminary adoption initiatives by non-governmental organizations but in a much unorganized way , the question has shifted from "should we adopt BIM?" to "how do we begin?" This leaves a significant void in the literature on the "how-to" of implementation. There is a distinct absence of research that systematically identifies and prioritizes the basic and prerequisite elements required to construct a successful BIM Execution Plan tailored to the Yemeni setting.

As a result, this study aims to transform the research paradigm from problem identification to solution development. It seeks to close this essential gap by pursuing two primary objectives. First, to evaluate the current state of BIM usage within the Yemeni construction sector to establish an empirical baseline. Second, building on this understanding, to identify and evaluate the key requirements for establishing a successful BIM Execution Plan. By doing so, this research intends to deliver the first empirically confirmed, expert-based roadmap of fundamental needs, allowing local enterprises to take their first systematic and confident steps towards BIM adoption.

II. LITERATURE REVIEW

A. Building Information Modeling (BIM)

BIM is a set of interacting policies, processes and technologies generating a methodology to manage the essential building design and project data in digital format throughout the building's life-cycle[18-21] also supports the concept of integrated project delivery, which is a novel project delivery approach to integrate people, systems, and business structures and practices into a collaborative process to reduce waste and optimize efficiency through all phases of the project life cycle[21, 22] . Although the roots of BIM can be traced back to the parametric modeling research conducted in the USA and Europe in the late 1970s and early 1980s, Architecture, Engineering, and Construction (AEC) industry practically started to implement it in projects from the mid-2000s. During the last seven years, the term BIM has gone from being a buzzword to the centerpiece of AEC technology [23]. In summary, Building Information Modeling (BIM) is an advanced digital technology that enables the creation of three-dimensional models of buildings and structures with the integration of all associated information[20, 24-27] , thereby facilitating more efficient and effective planning, design, implementation, and operation[28, 29] .

B. BIM Execution Planning .

According to [5], a BIM Execution Plan (BEP) is the foundation for successfully integrating BIM into project delivery. This document serves as a strategic guide, outlining the project's general BIM vision and giving actionable specifics for the team. It is intended to be a live document, starting in the early stages and subject to ongoing changes and revisions as the project grows and new team members join.
The BEP includes key components such as defining the scope of BIM use, specifying the workflow for specific jobs, detailing information exchange protocols, and outlining the supporting infrastructure. The process of creating a complete BEP is sometimes split down into five steps, as seen in Figure II-2.

Figure 1 : The BIM Project Execution Planning Procedure

The creation of a BEP brings tremendous value by reducing uncertainty and thereby lowering project risk [5]. A case study from Taiwan reveals that a BEP created for Facilities Management (FM) was a highly effective management strategy. The researchers highlighted a dual benefit: not only does it streamline maintenance activities, but it also enables BIM to support the building's whole lifecycle[30]. This clearly underlines the need for building administrative tools such as the BEP to amplify the benefits of BIM.
It is critical to distinguish between two main types of BIM Execution Plans: prescriptive and descriptive. A prescriptive BEP[31, 32], as defined by, is one that orders or requires the required usage of specified implementation features, which is often enforced by the project owner. In contrast, a descriptive BEP acts as an informative guide, depicting or illustrating the recommended steps to take.
This distinction is especially pertinent to the current state of the Yemeni building industry. Given the lack of a national BIM mandate and the fact that contractual agreements frequently only require the usage of individual[14], fragmented BIM applications such as collision detection or 3D modeling the concept of a comprehensive, owner-enforced prescriptive BEP is essentially irrelevant. As a result, the current conversation in Yemen focuses on the development of descriptive BEPs. The fundamental requirement is for plans that clearly specify the methods, standards, and workflows needed to properly carry out a limited and contractually defined BIM scope.

BIM Implementation Requirements

The global attempt to standardize Building Information Modeling (BIM) adoption has prompted various countries to produce implementation guidelines, sometimes as a result of government incentives or nongovernmental activities. One distinguishing feature of these publications is the lack of a single, universal method to implementation; each guideline is tailored to its own national or regional setting. Examples of relevant recommendations include the AEC (UK) BIM Technology Protocol, the American Building Information Modeling Execution Planning Guide, and the French Good Practices for BIM Collection, among others

Despite their diversity, a thorough examination of these core criteria reveals a set of recurring, critical needs for effective BIM adoption. An important study[33] examined a variety of these texts and successfully synthesized their basic components into twelve fundamental needs. This list of universally recognized criteria is an excellent starting point for any firm embarking on its BIM journey According to the study, they were as follows:

Define Metrics: Establish measurable units to evaluate implementation processes and track improvements against traditional methods.

Define Goals: Determine desired proficiency levels and specific improvements to be achieved within a set timeframe.

Develop an Implementation Plan: Create a strategic roadmap that identifies current resources, outlines needs, and sets methodologies and deadlines to meet objectives.

Define BIM Uses: Select and prioritize BIM applications that offer the greatest return on effort and align with company objectives.

Develop an Implementation Plan: Determine desired proficiency levels and specific improvements to be achieved within a set timeframe.

Restructure IT Resources: Select and configure the necessary software, hardware, servers, and network infrastructure to support BIM workflows.

Provide Continuous Training: Implement an ongoing training and skills assessment program for all team members.

Define Implementation Support: Secure both managerial support from leadership and technical support for software and infrastructure.

Define a BIM Workflow: Design a customized workflow that suits the company’s unique processes and defined BIM uses.

Define Internal Standards: Establish or update company standards, including templates, libraries, and naming conventions, to ensure consistency.

Start a Pilot Project: Execute a trial project to practically apply and validate all aspects of the implementation plan.

Check and Review the Plan: Periodically analyze progress and feedback to reprogram and refine the implementation strategy

It is important to distinguish between two different levels of requirements in the literature. While the current discussion focuses on the requirements for formulating an organizational framework for a BIM Execution Plan [5] which serves as broad, reference guidelines for the entire organization other studies have addressed a lower, more granular level. This research has identified the detailed operational requirements needed for a BEP at the individual project level. Among the studies that have addressed this detailed aspect are[8, 34].

These studies [8, 34] propose that a comprehensive BIM Execution Plan should be structured as a detailed roadmap, often initiated using a standardized Template to define the project's foundational parameters[35]. This begins with articulating the BIM Project Scope, its objectives, and the specific Roles and Responsibilities of each team member[36]. Building upon this foundation, the plan then delves into the procedural core, establishing a clear strategy for Collaboration and Communication and setting precise protocols for Information Exchange,[11] including file formats and process maps. [36]This is further detailed by specifying the technical Modeling Requirements, such as the Level of Development (LOD), alongside clear procedures for Model Management to govern how digital assets are handled and stored. The framework also explicitly defines the project's Deliverables and Documentation,[6] outlining what will be produced and on what schedule. To support these activities, the BEP must specify the necessary resources, including the IT Software and Hardware infrastructure and the Analysis Plan and Tools to be utilized[37]. Finally, to ensure its viability as a living document, the plan must include its own Update Procedures and explicitly state its Legally Binding Nature to clarify its contractual weight among all stakeholders[38].

It is worth noting that certain specialized studies have delved deeper into this operational aspect, breaking down the broad principles into a much larger number of granular requirements. However, given the existing state of the Yemeni building industry, an initial investigation of such deep detail may be impossible for two reasons. First, there is a significant variation in these extensive listings from one reference to the next, indicating a lack of agreement on a single framework. Second, the ranking of these objectives varies greatly, making it difficult to create a clear starting point.

As a result, this study intentionally focuses on extracting and defining the broad standards and core needs that have the most widespread agreement across the majority of literature and global recommendations. The goal is to create a clear, agreed-upon, and basic framework that can serve as a practical and dependable starting point for companies in Yemen, rather than overwhelming them with details that might be disputed or inapplicable at the current stage of technology development.

III. RESEARCH METHODOLOGY

This study used a quantitative research approach to identify and assess the prerequisites for creating a successful Building Information Modeling (BIM) Execution Plan (BEP) in Yemen's construction sector. The approach was designed in a multi-phase format to ensure that the findings are supported by a strong theoretical foundation as well as empirical data obtained from the practical knowledge of relevant industry specialists...

A. Research Approach

The investigation was carried out in two integrated phases, which are important to this paper. Phase One consisted of an exploratory literature review to lay the theoretical groundwork and create a preliminary list of BIM implementation needs based on worldwide guidelines and proven foundational works. Phase Two, the primary quantitative field study, used a descriptive-analytical survey approach. The primary goal of this phase was to experimentally validate and prioritize the stated criteria in the Yemeni context. The quantitative methodology was chosen because it allows for the collecting of numerical data from a specific sample of experts, allowing for a systematic study of the perceived relevance of various needs and the creation of a practical, scientifically backed guidance for the industry.

Population and Sample The study population consisted of experts from Yemen's Architecture, Engineering, and Construction (AEC) industry with theoretical or practical understanding of BIM. This comprised project managers, academicians, and managers of engineering offices. Because of the shortage of specialists and the lack of official listings to utilize as a sampling frame, a non-probability sampling method was required.

The Snowball Sampling strategy was chosen as the most effective way to reach this qualified and specialized group. An initial set of known experts was identified, and they were asked to propose other qualified professionals in their network. The total sample consisted of 56 people. Despite its small size, it was deemed enough for statistical analysis considering the specialized nature of the research issue and the logistical obstacles in the Yemeni environment.

B. Data Collection Instrument and Validation

The major data collection tool was a structured questionnaire that was carefully designed to fit with the research objectives. The instrument contained two major portions pertinent to this paper:

Section One: Participant Profile and Context: The purpose of this section was to collect necessary background information to develop a profile of the study sample. It includes biographical information such as job title and years of experience, as well as a critical contextual question designed to assess participants' self-reported levels of BIM usage in their current projects. This question offered an overview of the current state of BIM application in Yemen.

Section 2: Requirements for BIM Implementation: This core component, meant to answer the key research question, gave a list of prospective BIM implementation needs taken from [Please identify the main references from which the criteria were extracted]. Respondents were asked to assess the importance of these requirements.

To assure the instrument's quality, a comprehensive validation process was implemented. A team of academic specialists in project management from Sana'a and Ibb universities evaluated the questionnaire thoroughly to determine its content validity. These experts evaluated the items' clarity, relevance, and consistency, and their valuable feedback was used to improve the final instrument. Furthermore, a pilot study was carried out with a small, representative sample of participants (academics and project managers) to test the phrasing, flow, and time necessary to complete the questionnaire, resulting in minor final changes.

C. Data Collection and Analysis

Upon The verified questionnaire was translated to digital format with Google Forms. Over the course of six weeks, the link was sent to the targeted respondents via email and professional networking platforms.

Following collection, completed surveys were coded and entered into IBM SPSS Statistics (Version 27) for analysis. The data analysis methods included:

Descriptive Statistics: Frequencies and percentages were used to describe the sample data and determine the level of agreement among experts on each suggested requirement.

The One-Sample T-Test was performed to examine the significance of the replies on the current level of BIM usage by comparing the mean response to a neutral value.

The analysis of frequencies and percentages enabled the ranking of requirements based on how frequently they were identified as 'necessary' or 'possible,' ultimately resulting in the identification of the most important requirements for developing a successful execution plan in Yemen, as well as the feasibility of their provision and adherence.

IV. RESULTS AND DISCUSSION

This section presents and discusses the findings obtained from the quantitative analysis of the 56 questionnaires completed by Yemeni construction industry experts. The results are presented in two main sections, corresponding to the study's primary objectives: first, an evaluation of the current level of BIM usage in Yemen, and second, an identification and analysis of the necessary and possible requirements for developing a successful BIM Execution Plan.

A. The level of BIM usage in the projects

The study's first goal was to create an empirical baseline for the present level of BIM utilization in Yemen. The findings unambiguously confirm the research's premise: BIM adoption in Yemen's construction sector is still in its early stages. When asked to rate the level of BIM usage in their projects on a five-point scale, participants gave an average score of 2.45 (SD=1.235). A one-sample T-test found that the mean is considerably lower than the theoretical midpoint of the scale ($t = -3.355$, $p < 0.01$), indicating a preference for limited or low application.

This empirical finding is highly consistent with the body of research on BIM adoption in developing nations and conflict-affected areas. For example, studies undertaken in similar environments, such as[39], found low levels of adoption, noting hurdles such as high initial costs, a lack of government assistance, and a paucity of experienced specialists. Our discovery that even a sample of BIM-aware specialists in Yemen indicate little utilization confirms the findings of previous diagnostic research on the Yemeni environment, such as[14], which revealed major hurdles to technology deployment.

As a result, this finding is more than just a descriptive statistic; it provides vital support for the study's core goal. It experimentally verifies that the difficulty in Yemen is not maximizing a mature technology, but rather overcoming the initial barriers to acceptance. The low utilization level highlights the critical need for a clear, context-specific deployment roadmap, which this study seeks to address by defining the fundamental elements for a successful BIM Execution Plan.

B. BIM Implementation in Projects

The second, and primary, objective of this study was to identify the key requirements for developing a successful BEP. The ten identified requirements were evaluated by experts, who classified them as either "necessary" or "possible". The following sections present these findings and discuss their implications.

Table 1. Results of the T-test & arithmetic mean & relative weight for the level of BIM usage in the projects

No	Paragraph	Mean	Standard deviation	Relative %Weight	T Test	Sig level
1	What is the level of BIM usage in the projects you are working on?	2.45	1.235	49	-3.355	0.001*

C. Necessary Requirements for Implementing BIM Model

The results in Figure 1 provide a clear hierarchy of priorities as perceived by Yemeni experts. A detailed analysis reveals three distinct tiers of importance:

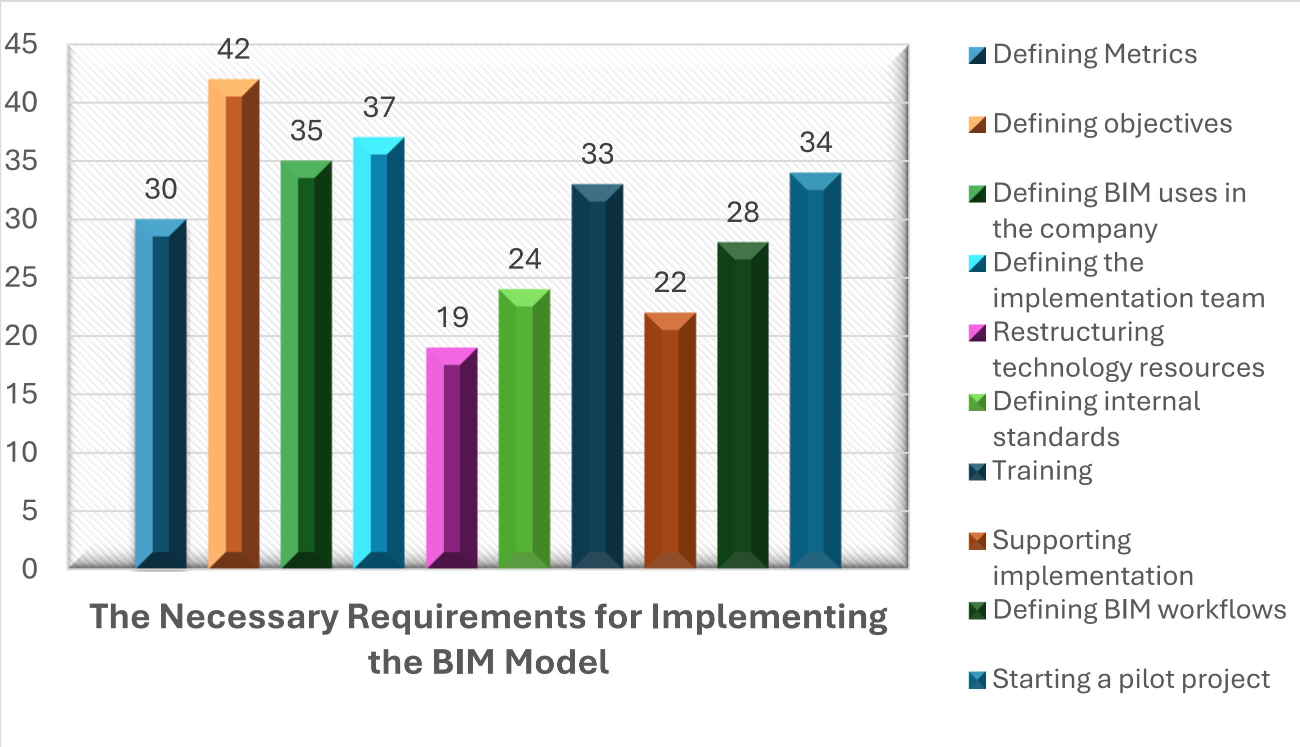

Figure 2. The Necessary Requirements for Implementing the BIM Model

The Strategic Tier (Top Priority): It is highly significant that the three most frequently cited requirements are purely strategic and organizational. "Defining objectives" emerged as the most critical requirement, with 13.82% of the responses. This was closely followed by "Defining the implementation team" (12.17%) and "Defining BIM uses in the company" (11.51%). This strong consensus underscores a crucial insight: for experts in Yemen, a successful BIM journey begins with strategy, vision, and people, not with technology. This aligns with established management literature which posits that a clear "why" (objectives) and "who" (team) must precede the "how" (process) and "what" (tools)[40].

The Procedural Tier (Middle Priority): The next set of requirements focuses on developing the processes and skills. "Starting a pilot project" (11.18%) and "Training" (10.86%) were ranked highly, indicating that after setting the strategy, the next logical steps are to test the plan on a small scale and equip the team with the necessary skills. This reflects a practical, hands-on approach to implementation, were theory is quickly put into practice. It should be noted that "Defining Metrics" also falls within this tier with a high ranking, serving as a crucial component for evaluating the success of the pilot project and the effectiveness of the training

The Technical and Support Tier (Lower Priority): Interestingly, the requirements perceived as least critical among the necessary items were related to technical infrastructure and support. "Restructuring technology resources" was ranked last, with only 6.25% of responses. This is a counter-intuitive but vital finding. While BIM is a technology-driven process, Yemeni experts appear to de-prioritize the immediate, large-scale investment in hardware and software. This could be attributed to several factors unique to the local context:

This de-prioritization of technology can be attributed to several interrelated factors rooted in the local context. Primarily, a strong sense of cost and risk aversion likely plays a significant role; the high capital investment required for BIM technology may lead firms to postpone this expenditure until the strategic and procedural framework has been proven effective through a small-scale pilot project. This cautious approach is complemented by a strategic focus that reflects a mature understanding of technology as merely an enabler, not a solution in itself. There is a clear recognition that without well-defined goals, standards, and workflows, even the most advanced software will fail to deliver its promised value. Finally, a potential lack of awareness may also contribute, as some participants may not fully grasp the demanding technical specifications and infrastructure required for complex BIM models, thus underestimating the importance of this requirement at the outset.[15, 17, 39]

D. Possible Requirements for Implementing BIM Model.

To add another layer of understanding to the implementation priorities, the study asked experts to identify requirements that they thought were "possible." This category distinguishes between non-negotiable core features and those that are crucial but allow for more flexibility. The analysis of this category reinforces the "strategy-first" hierarchy observed earlier.

"Defining objectives" was once again the top-ranked criteria (13.25%). Its dominance in both the "necessary" and "possible" categories solidifies its position as the fundamental foundation of any BIM initiative in Yemen. This dual emphasis implies that setting explicit goals is both a non-negotiable starting point and an ongoing, adaptive activity throughout the project's lifecycle.

Similarly, "Defining the implementation team" (11.14%) and "Training" (11.14%) retained their top priority. Their high prevalence in all categories emphasizes the idea that organizational preparation and human capital development are critical for resilient and successful implementation, a theme that is frequently repeated in change management literature. The data also revealed a more fair distribution of additional procedural needs, such as "Defining BIM uses" and "Defining BIM workflows" (both at 10.54%), implying that they are considered as an interconnected cluster of significant tasks to be carried out once the basic strategy is established[40]. It is also important to note that "Defining Metrics" was ranked highly within this cluster, reinforcing its role as a key procedural step

Crucially, and in line with past studies, "Restructuring technology resources" was ranked last (6.02%). This persistently low ranking supports the premise that Yemeni professionals see large capital investment in IT as a discretionary and potentially deferrable move rather than a necessary precondition. This risk-averse approach, which prioritizes low-cost strategic planning above high-cost technological overhauls, is a realistic response to the economic uncertainties of a developing context, according to studies on technology adoption obstacles. [15, 17, 39]

This study differs from previous research in its approach to defining requirements. The majority of the research has focused on evaluating documents to establish the "components" of a project-level BEP, but this study takes an expert-centric, empirical approach to identifying the "foundational requirements" for organizational preparation. Instead of comparing individual items, we compare the overall priorities. The emphasis on strategic and human-centric elements in our findings, in contrast to the technical details dominating component-based lists, demonstrates that our research does not contradict previous work, but rather complements it by addressing a more fundamental, preparatory stage that has previously been overlooked.

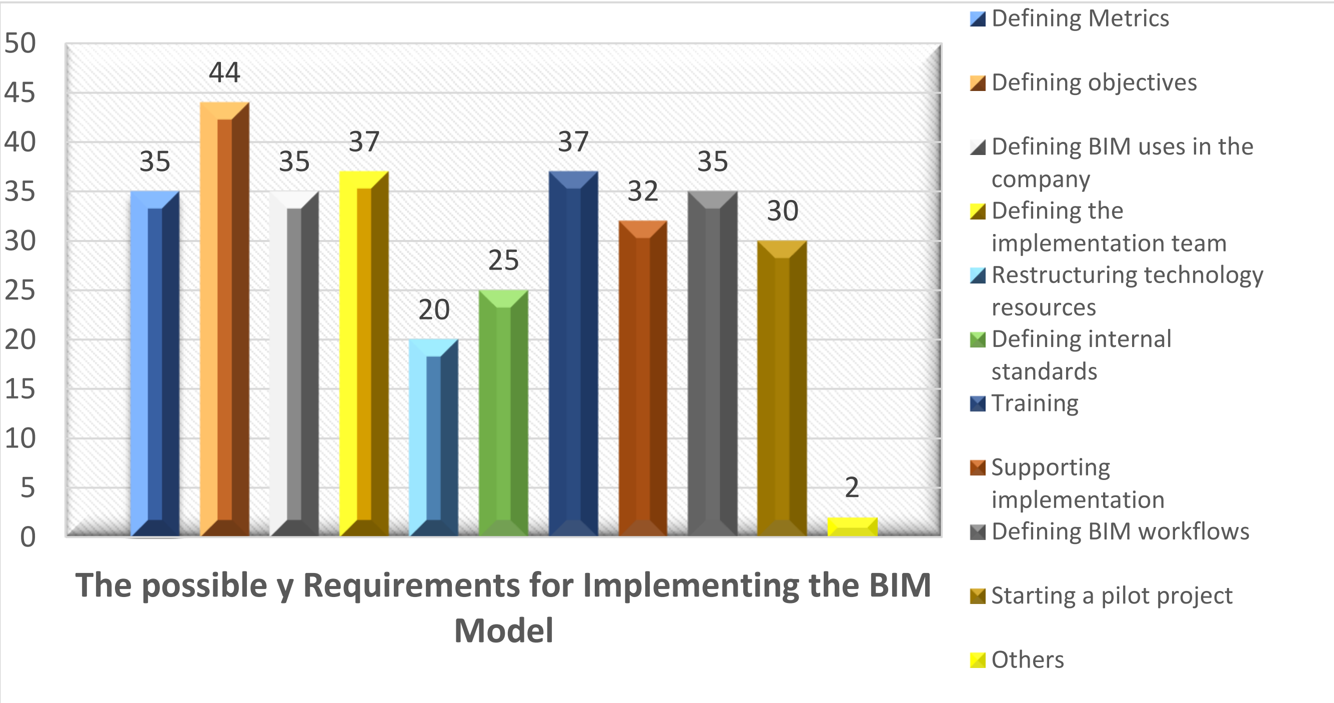

Figure 3. The possible Requirements for implementing the BIM Model

V. CONCLUSIONS

This research was designed to address the dual challenges of low BIM adoption and a lack of a defined implementation plan in the Yemeni construction sector. It had two main goals: first, to assess the current level of BIM utilization, and second, to prescribe a set of verified conditions for a successful BIM Execution Plan. The research has effectively met these objectives, providing not just data but a strategic interpretation that offers a clear path forward for local industry professionals

The findings validated the research's central premise: BIM usage in Yemen is still in its early stages, emphasizing the crucial need for a guiding framework. In response, the study effectively identified and validated ten critical implementation criteria. The classification of these requirements into "necessary" and "possible" categories was useful because it revealed a distinct hierarchy of priorities that was specifically tailored to the local context.

The most notable contribution of this study is the identification of a definite "strategy-before-technology" approach among Yemeni professionals. The data clearly shows that core, non-negotiable needs are strategic and organizational, with defining objectives and forming the implementation team" continuously ranking as the most important. In contrast, the persistently low ranking of "restructuring IT resources" is a critical result. It reflects a pragmatic and risk-averse approach, with large capital investment in technology considered as a flexible, deferrable action that should only be undertaken once a sound strategic and procedural foundation has been established.

Recommendations

Finally, this study provides a strategic, risk-mitigating, and context-specific implementation model, rather than just a checklist. The hierarchical ranking of requirements represents a profound, experience-based logic, allowing businesses to lay a solid foundation by prioritizing low-cost, high-impact strategic needs before committing to resource-intensive operations. The primary recommendation for practitioners is to use this phased, strategy-first approach to reduce risk in their investments.

A pragmatic approach is recommended in light of the technological requirement's continually low ranking. Rather than making a large upfront expenditure, businesses can take advantage of the noticeable, albeit minor, shift in technical infrastructure available to practitioners. This could include emphasizing cloud-based collaboration platforms, maximizing the use of current technology, and, hence lowering the technological barrier.

Limitations and Future Research

The study's conclusions, while enlightening, should be examined in light of several limitations. The use of a non-probability snowball sample, while necessary for the context, means that the results reflect an expert opinion rather than being generalizable to the whole business. Furthermore, the results are based on the experts' self-reported perceptions. These constraints open up several important options for further research:

A thorough examination of the core components of a BEP, tailored to the specificities and contractual realities of the Yemeni market.

The creation of a national or industry-specific BIM guideline in Yemen to standardize processes.

research of the viability of incorporating BEP requirements into a standard Yemeni BIM contract template to achieve formal acceptance.

Longitudinal case studies to track the implementation of the proposed phased model and quantify its influence on project performance.

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