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A Qualitative Study on Factors Influencing Technology Adoption in the Architecture Industry

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Abstract: The architecture service industry has typically been slow in accepting new digital technologies due to many reasons, such as the industry's complexity, the diverse sizes of companies, client types, and stakeholders' technical skills. The combination of these business service factors with those that affect the intention of a user to use a technology offers a novel model for predicting the success of technology adoption in this business. This study aims to identify the factors in the architecture industry that influence the process of technology adoption. The process of qualitative data collection was conducted using semi-structured interviews with the participation of 30 architecture and design managers to explore the factors that they consider important when adopting digital technology in their organizations. This was conducted to compare these factors with those identified by users as influential in the adoption of digital technology. The analysis was conducted in three stages, namely transcribing, coding, and extracting major themes. This study will further help in identifying whether managers viewed the factors identified in the quantitative study as significant in affecting their decisions to adopt the technology. The major findings of this study revealed that several factors influence the adoption of technology in the architecture industry at the managerial level. These factors include cost, brief preparation, service quality, result demonstrability, project time, environmental considerations, training considerations, and user-friendliness.

Keywords: sustainable buildings; emerging technologies; architecture industry; technology adoption; productive work

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1. Introduction

Most of the research on technology adoption is based on Rogers' diffusion theory and Davis' technology acceptance model (TAM), which investigate the diffusion rate of different types of innovations within an industry. In the present research, to "adopt something" in the industry is to arrange access for employees to use it on an everyday basis. Technology adoption is defined as "the process of communicating and implementing technology through specific channels over time among the members of an organization" [1] (p. 5), as well as the process of sharing the information and knowledge of successful use of new technology.

Digital technology refers to "information and communication technologies (ICTs) that facilitate the development, storage, and handling of information and promote the various forms of communication between human beings and electronic systems and between electronic systems in digital binary computing" [2] (p. 1). Digital technologies are sophisticated information and communication technologies that facilitate the processes of collecting, storing, processing, demonstrating, and integrating information [3,4]. For this research, the concept of digital technology is extended to include Digital Management and Assistance Technology (DMAT), which refers to advanced technologies and tools used in managing and assisting architects to improve productivity across the architectural design and construction life cycle. Some examples of digital architectural technology referenced

in the present research include BIM, SketchUp, Rhino, Microsoft Project, Primavera, and Ecotect.

The architectural service industry is arguably more diverse and complex than most other sectors where TAM has previously been applied (manufacturing, engineering, etc.). Architectural firms come in many different sizes and types. The tasks undertaken by architectural firms are highly diverse, including brief preparation, data modeling, results demonstrability, cost-effectiveness, project time constraints, service quality issues, training considerations, and environmental simulation [5,6]. The unique characteristics of architectural practices necessitate the development of a TAM-equivalent model to improve the current understanding of these issues. This will assist architectural practices to understand when, how, and why to uptake a new technology. This is the underlying motivation for the present research. The overarching aim of the research is to explore factors influencing technology adoption in the architecture industry at the managerial level.

2. Literature Review

A wide range of digital technologies have been introduced to the architectural service industry by researchers and practitioners to support streamlining work processes, enhance organizational productivity, and improve the overall outcomes of the design process [7–12]. In the 1950s, for example, architectural digital technology systems, such as computer-aided design (CAD) and drawing technology, were developed to aid architectural companies in design creation and documentation. Despite some resistance and debates around the acceptance of these tools by designers, who were often focused on the value of free-hand sketching, the technology was gradually accepted across the sector in many countries [9,13]. More recent and advanced digital technology, such as building Information modeling (BIM), has provided centralized systems for the automation of architectural processes, from 3D modeling to material specification, construction simulation, and facility management [14].

A necessary inference that past research imparts is that digital technology adoption greatly depends on organizational factors affecting users and clients and the managerial decision-making procedure. The dependent variables are the primary function of digital technologies. However, the three actors involved in the architectural organization, namely users, clients, and managers, play a significant role in the overall decision to adopt technologies. Factors that affect the adoption of digital technology have been studied in a variety of contexts and against an assortment of frameworks. Sagnier et al. investigate the same dynamics with regard to virtual reality using the technology acceptance model [15]. Various approaches have been taken in the architecture industry. Technology in architecture has various applications, ranging from the use of mixed reality for designing structures and creating construction layouts to glazing applications and Smart Grid applications using the internet, among many others [16–18]. Despite the plethora of applications and benefits that can be derived from the use of technology, there are still various factors that cause reluctance in the adoption of technology across the industry. For example, Raznekari et al. [19] highlight the suppressed use of fabrication technology in the United States and highlight various industry factors. That study used qualitative data accumulated from unstructured interviews and questionnaires disseminated during the State-of-the-Art of Modular Construction Symposium. The study's concomitant findings indicated that the high cost of technology, complex logistics such as limitations to assembly, a lack of expertise, and design limitations were factors contributing to the reluctance to technology adoption. Raznekari et al. [19] further expand on the problem, including the external environment, citing the user-friendliness of technology, ease of use, and usefulness as significant factors in the decision-making process for adopting digital technology.

Implementation costs are a significant factor. The cost of purchasing the most innovative digital technologies is high and remains a top inhibitor [20,21]. The price of the technologies is said to be high and beyond the reach of the majority of small and middle-size firms. Jamal et al. [20] conducted a qualitative analysis of the problems facing the widespread use of building information modeling in Malaysia's architecture industry and

made the finding that cost significantly hampers the process. Similarly, de Soto et al. [21] evaluate the cost-efficiency of applying robotics in construction through a case study and find that there is a degree of uncertainty in the cost of the robot and its payback period. Their findings suggest that the use of robotics only outperformed conventional methods when building complex walls, but not in any other application.

Another significant hurdle to technology adoption is limitations in experience and technical knowledge due to training considerations. In a descriptive study, Ko [22] found that the technical design of the technology was a significant impediment in that there was limited know-how on how to navigate it. Jamal et al. [20] found the lack of a skilled and experienced labor force capable of implementing a building information modeling design. However, the aforementioned factors represent the internal factors that may impede adoption within a specific firm. Various components of the industry may also affect the adoption of technology within a specific firm. Such factors include the uncertainty of market demand. While the evidentiary base for technology may be firm enough to warrant adoption, the limited number of consumers may prove cost-ineffective. Abhari and Abhari [23] develop a theoretical model that explains the slow adoption of ambient intelligence in architectural design and acknowledges the reality that the demand is still limited. In addition to demand, the overarching policy and legal framework may be composed of restrictive laws that discourage architects from adopting innovation into their practice. Zhang et al. [24] find that policy is underutilized as a tool for improving the uptake of smart building technology due to the conservative nature of major industry players.

It cannot be assumed that new technologies that replicate or automate design tasks and architectural workflows will automatically be embraced by the architectural service industry. Instead, past research suggests that decisions to adopt technologies are often contentious, and it has even been argued that digital technologies are viewed as "disrupters" in the architectural service industry [25,26]. The arguments presented serve as a catalyst for the present study, which aims to understand the reasons behind the reluctance of architectural practices in certain regions to adopt new digital technologies. Similar questions have been raised in other industries and contexts, leading to the development of a TAM by Davis [27], which provides an important tool for understanding user behavior in adopting a particular technology in some industrial contexts. The TAM model measures two specific factors—"perceived usefulness" and "perceived ease of use"—against the actual use of the technology to determine the level of technology adoption [27]. However, the TAM is not optimized for understanding technology adoption in the architecture industry.

While there are many examples of famous architects who have been celebrated for their rapid adoption of technology—such as Frank Gehry, Zaha Hadid, or Norman Foster—past research argues that many firms, as well as some countries and cultures, have resisted adopting technology [28–30]. Some researchers suggest that the reluctance stems from a poor understanding of technology and its benefits and risks [5,31], and this failure results in low productivity and reduced quality of building designs [32,33]. Furthermore, it is claimed that the specific organizational factors affecting technology adoption in the architectural industry remain undetermined [34,35]. Certainly, research into the building industry, which has close professional ties to architecture in many parts of the world, suggests that technology is influenced by factors such as perceived ease of use [13], complexity, and cost of technology systems [20,36], as well as customer and vendor-related attributes [37]. However, despite these examples in a related sector, relatively few attempts have been made to predict and understand the process of technology adoption in architecture. The few attempts that do exist are either not applied in the architectural industry [13,38] or they borrow general acceptance models from IT [13,38]. Given this brief background summary, the problem that the study addresses is the reluctance to adopt technology, which is a factor that often results in reduced quality of designs.

3. Materials and Methods

3.1. Data Collection and Materials

A semi-structured interview is a type of interview that is a mixture of closed and open-ended questions. The interviewer asks only a few predefined questions while others arise spontaneously in a free-flowing conversation. They are identified by the open-ended questions of the interviewer, and it allows the interviewer to add his/her opinion on some interesting questions and issues. They are commonly used to obtain different responses from respondents and enable a mixture of qualitative and quantitative information to be gathered. The main survey instrument for the study was unstructured interviews that were used for validation purposes. A total of 30 managers were identified through chain sampling and interviewed to collect their perspectives on the influence of organizational factors in their decision-making process regarding the adoption of new technologies. Semi-structured interviews were selected as the best data collection method, as they offered the researcher an opportunity to explore the factors under study. The instrument is flexible and thus can be used to generate enough data to advance the understanding of technology adoption in the architecture industry [39]. A major benefit of the interview is that respondents are more comfortable with the researcher than they would be if they were filling out a survey. Other advantages of in-depth interviews include depth, disclosure, quality of data, and short timelines. In-depth interviews can uncover valuable insights in terms of intensity. When the interviewer probes for more information, the quality of the data improves. Questions can be added or changed in real-time if needed; however, in this study, the researcher did not change questions during interviews. Data from interviews can also be collected faster, usually within a few weeks [40]. However, interviews also have limitations. Firstly, there is an element of bias when the interview is conducted. Biases can result from the effect that the researcher can have on the respondent. Secondly, interviews are very time-consuming. Furthermore, researchers should carefully use qualitative research methodologies. This is due to the occurrence of the Hawthorne effect, which can influence the overall research outcome [41]. This can be explained by assuming that the researcher influences the interviewee with respect to the detailed 32 and descriptive discussion of the topic. In such cases, the entire discussion shall be inclined toward the opinion of the researcher rather than the interviewee. Therefore, in this study, the researcher was careful not to influence the respondents to the extent that their opinions were altered, as suggested by Tong [40].

The structured interview approach was not suitable for this study due to its limitation of predefined questions, which could limit the respondents' answers in a specific way. Instead, the researchers opted for semi-structured interviews, as they provided an opportunity to explore the factors under study and gather opinions. Additionally, the data analysis for structured interviews would have been time-consuming. However, according to Kallio et al. [42], structured interviews offer the researcher a deep understanding of the concepts under study. The likelihood of getting true variations in practices in different firms is high through semi-structured interviews.

3.2. Analysis

Thematic analysis is a qualitative method that emphasizes and pinpoints patterns in various themes in research [43]. For the present research the analysis was undertaken using Nvivo software. According to Kiger and Varpio [44], thematic analysis of qualitative data is a powerful technique for exploring or trying to understand the experiences, behaviors, and perceptions of a given population. Previous studies, such as [45,46] have used this method to understand perceptions pertaining to technology adoption within the architecture, engineering, and construction industries. As such, other studies have succeeded in achieving their research objectives using the analysis technique. The thematic analysis would facilitate the division of data into analytical units, which would contribute to an in-depth understanding of the influence of the factors on the technology adoption process [43,47–49]. An inductive approach, as suggested in grounded theory [48], is used in the identification

of themes from the interview transcripts. An inductive approach, according to Braun and Clerk [50], reduces any chance of the researcher's bias, as it is data-driven, examines the data collected from the interview participants in depth, and does not mirror the exact questions asked during the interview.

For the present research all interviews were transcribed into Nvivo and went through the process of microanalysis and coding. The process of analysis was broken into three stages, namely: transcribing of data, coding of data, attaching it to relevant nodes, and drawing meaningful themes. The interviews were broken down using smaller sections, namely passages that allow for easy classification and the creation of meaningful ideas [51], from which themes are developed. According to various authors [44,47,50], different criteria need to be used in choosing the passages to avoid missing any useful ones. One of the criteria used involved identifying any examples of technology adoption. The second method identified any sentences with words such as influence, contribute, and affect and factors tested in the quantitative phase. The third method involved checking for new ideas not related to the factors.

The passages were then coded in relevant "child" nodes, with each representing either an activity, an idea related to technology adoption, or a factor influencing technology adoption. For consistency, signal words such as "we always", "we consider", "we do", "we use", and "we do not" are used to select passages. In case no relevant node to the passage selected existed, a new node was created. Once the nodes were created, the next step was to identify the themes. Related child nodes were put under one "parent" node, which presented the themes of the study. Some of the passages would later be used as verbatim quotes in discussing the results.

According to Attride-Stirling [52], themes are often the lowest forms of premises evident in data. Each theme represents the findings of the qualitative phase, in which each of the child node findings is discussed later and used to validate the findings of the quantitative phase of the study and to generate ideas or emerging concepts. Finally, the identified themes are reviewed through the refocusing of data and the transcript to check if there is sufficient data identified under each of the themes and also if the data warrants the separation of the themes [44]. This is accomplished by cross-checking the coded passages and checking if there is more information that can be coded from the transcripts. The themes of the study are reported after reviews and discussed in detail in the findings section.

4. Results

The process of qualitative data collection was conducted through semi-structured interviews with the participation of 30 architecture and design managers. The interviews aimed to explore the factors that they consider important when adopting digital technology in their organizations. This study also sought to compare these factors with those identified by users as influential in digital technology adoption. The analysis was conducted in three stages: transcribing, coding, and extracting major themes. This study starts by discussing demographic factors such as gender and their influence on the technology adoption process in the selected organizations. This study will further help in identifying whether managers viewed the factors identified in the quantitative study as significant in affecting their decisions to adopt the technology.

4.1. Transcribing

A total of 30 interviews and 1080 min of interview recordings were transcribed. The interviews were conducted and audio-recorded in Arabic. The rationale behind using Arabic was based on the fact that the interviewees used Arabic as their native language and were not very conversant with the English language. The recordings were transcribed in English by the student investigator, who is fluent in both languages, in order to facilitate the qualitative analysis using NVivo 12 and present details of the analysis in the present

dissertation. The transcribed interviews were checked thoroughly for grammar and given identifiers from 01 to 30 before being imported into the NVivo software.

4.2. Results of Thematic Analysis

The section presents the thematic analysis and results of information transcribed from 30 respondents to facilitate the process of coding analysis and identify related concepts and themes. The parent nodes can be an indicator of a possible theme emerging from the transcriptions. There are multiple child nodes under each parent code, which may represent the subthemes or a set of related concepts at a lower level of the analysis. The coding process commenced by identifying passages and quotes related to technology adoption. The processing of the passages generated nine nodes, which represented the major themes. Figure 1 below shows the nodes/major themes extracted from the passage analysis. The nodes were generated as follows:

- Environmental Concerns for Technology Adoption
- Impact of Technology on Service Quality
- Influence of Firm Size on Technology Adoption
- Project Time Concerns Before Technology Adoption
- Role of Gender in Technology Adoption
- Satisfaction Impact on Technology Adoption
- Technology Ability to Produce Desired Results
- Training Concerns Before Technology Adoption
- Types of Costs in Technology Adoption

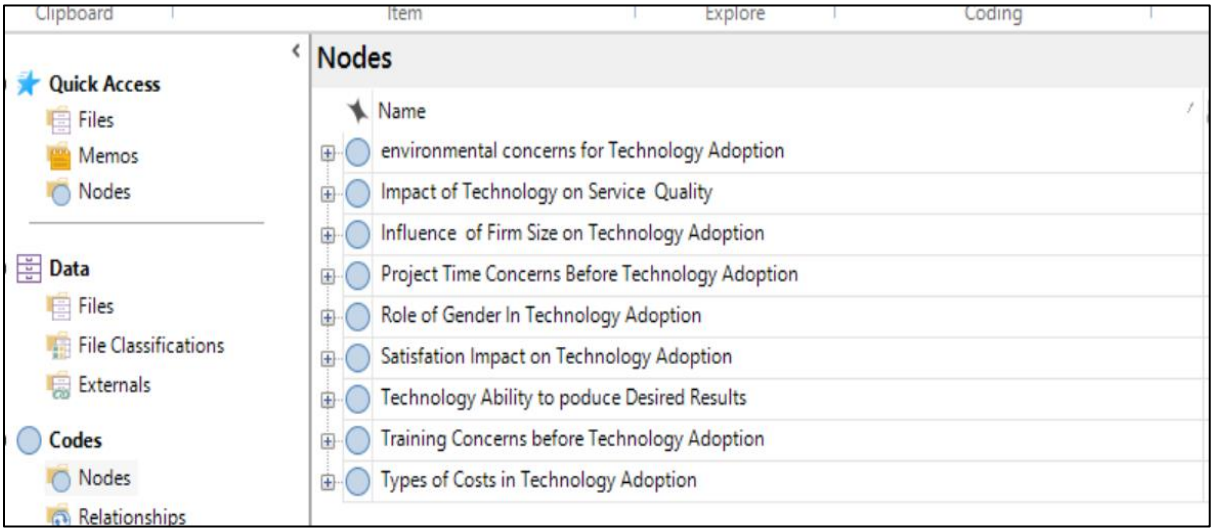

Figure 1. An example of the node structure created in NVivo.

Figure 2 shows the parent nodes and child nodes. The coding process involved reading through each interview and coding the information related to the different nodes, as shown in Figure 2 below. Each of the parent nodes is attached to the relevant passages from the transcribing.

Each of the parent nodes was attached to the relevant passages from the transcribed text. For example, passages from the section of the transcription referring to environmental concerns discussing the awareness of environmentally friendly technology adoption were assigned to the node "environmental concerns for technology adoption". One of the child nodes lacks adequate technology to address environmental concerns, as shown below. The example passage is shown in Figure 3 below.

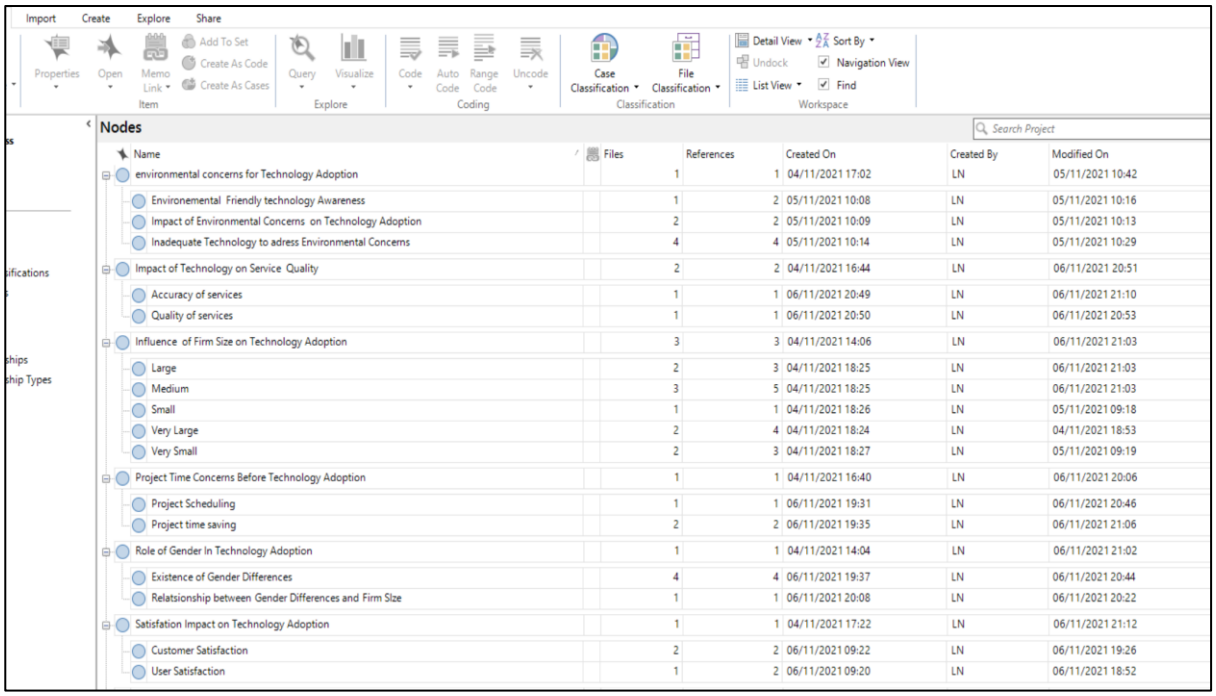

Figure 2. An example of the parent and child nodes' structure created in NVivo.

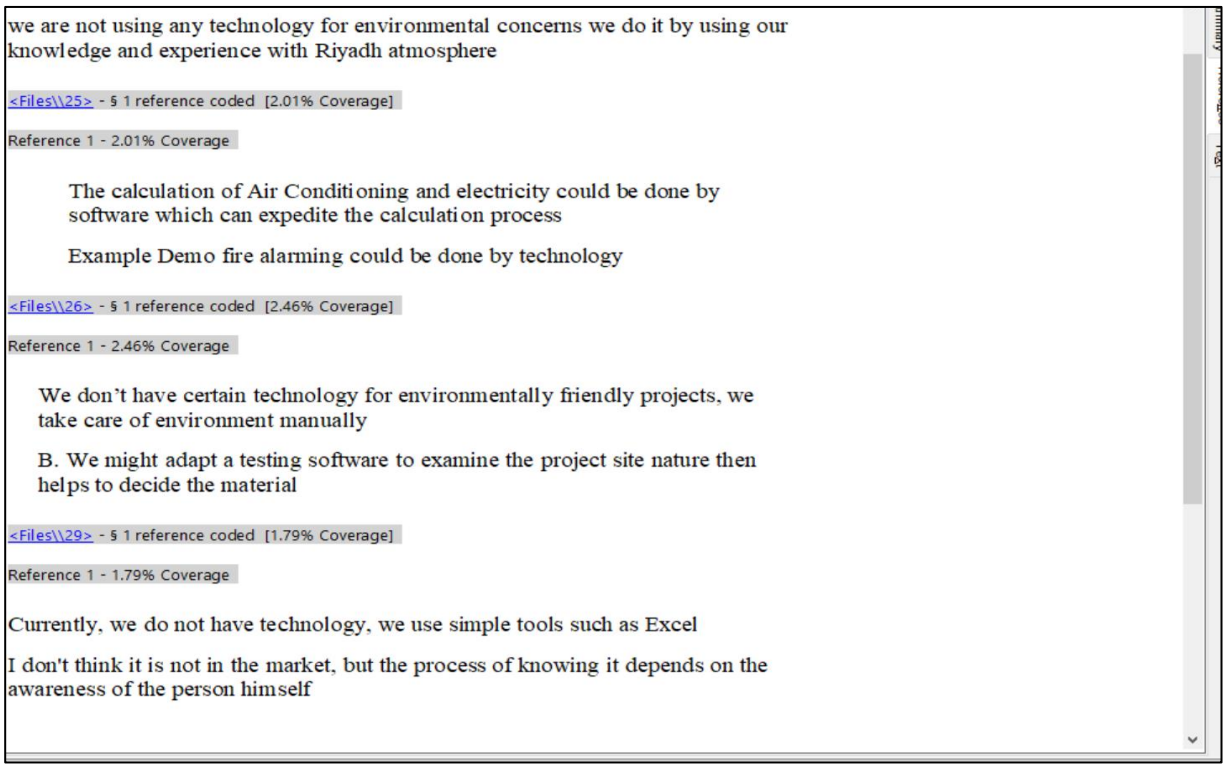

Figure 3. Example of coding the transcripts.

Note: Example passages from the section of the transcription discussing environmental concerns and the awareness of environmentally friendly technology adoption were assigned to the node Environmental Concerns for Technology Adoption.

The parent nodes and child nodes obtained from the analysis were renamed to themes and subthemes, as shown in Table 1 below.

Table 1. Summary of themes and subthemes from qualitative analysis.

Parent Node (Themes)	Nodes (Subthemes)	Examples of Responses from Participants
Role of gender	• Existence of Gender Differences • Relationship between Gender Differences and Firm Size	"Both genders accept adapting technology, but females are more familiar with the technology. For example, when we were setting up a training plan for our staff, the internal design chairman (#8) talked to me about how some of the male staff's level is weak in Microsoft, unlike the female staff, who were evaluated as advanced in using Microsoft basics". "No, there is no difference between genders, but there is a difference between the generations of employees".
Influence of firm size	• Large Firms and Technology Adoption • Medium and Technology Adoption • Small and Technology Adoption • Very Large and Technology Adoption	"For example, in the process of decision-making, as the organization gets larger, the process of taking decisions gets more complicated and bureaucratic". "To adopt a new system, you have to pass through a long administrative process and take multiple approvals until you reach the final approver". "In terms of company size, in my small firm, it will be easy to adopt the technology". "For example, now we are discussing the idea of applying a new system that will facilitate the process of project supervision. Some technology might be expensive, such as admin systems, which I think should be utilized based on the institution's manpower capacity".
Impact of different Types of cost	• Initial cost • Benefit cost • Operation cost • Variable cost	"The most important thing is that the cost of the technology is affordable, and then we can adapt once the scale of our employees increases". "Operational cost is the most significant cost because it will increase the working hour cost from 200 to 250, for example". "Another issue is that the costs of the licenses were very low and there was no focus on legal licenses". "After that, AutoCAD increased the license costs, and it became impossible to continue".
Technology's ability to produce desired results	• Ability to meet client requirements • Effective presentation of results	"At present, we do not need new technology because we are using the top technology on the market that allows us to deliver results". "Revit helps facilitate the coordination with all the members and gives early indicators". "Three-dimensional max helps us present high-quality images that we can present to the clients". "You have to consider in each project how you will present that project, and then what are the tools that fit with project rendering". "We have a huge number of results that we use to adapt technology".
Technology adoption and use in Brief preparation	• Most managers did not consider using technology for this process. • willingness to use digital technology • Use of conventional tools instead of advanced design tools	"We achieve the briefing stage manually". "We are not using any technology for briefings because 90% of our clients prefer physical meetings in our office, and we prefer hosting our clients to gain their trust". "However, if there is any effective technology that will help increase the efficiency of the office, we will not hesitate to adapt it". "We use manuals and some software, such as a spreadsheet". "Therefore, we are using technology at this stage for searching and investigation during the preparation of the briefing".
Project time conditions before technology adoption	• Project time saving • Project Scheduling	"We always conduct pilot work before adapting any system to test team acceptance and system outcomes that relate to quality or time savings". "By applying a demo or very extensive workshop, we test resource management and the efficiency of client management to determine if the project improves time".
Impact of technology on service quality	• Quality of services • Accuracy of services	"Technology has always given us positive feedback on our services". "We were working with the government sector, and we have a lot of pressure during the process of transferring to the private sector". "We had to adapt new technologies and strategies to cope with that transition and reach the target level". "The service quality related to design and measurement services has improved".
Environmental considerations	• Environmentally Friendly digital technology Awareness • Impact of Environmental Concerns on Technology Adoption. • Inadequate Technology to Address Environmental Concerns	"We prioritize environmentally friendly factors; for example, when we were working on the NEOM village, we took into consideration sun direction, solar energy, and other aspects too". "We concentrate on surrounding environment analysis in a huge project that might affect nature and wildlife, and we focus on weather impact analysis". "We do not have customized systems for environmental aspects, but we are aware of environmental aspects".
Training Concerns before adopting technology	• Concerns before adopting included • Trainees' resistance. • Trainee expertise and skills. • Training costs.	"The employees reject the training; some of them considered it an obstacle and burden". "In the process of adapting the system to 2D instead of 3D, we have encouraged the staff to learn Revit, but some of them attend the training and they do not know how to use it". "Overtime training gives the company additional cost".
User-friendliness impact on technology adoption	Aspects of concern included. • Friendly interface. • Easy access. • Easy usage. • Effective outcomes surpassed user-friendliness.	"I consider it a friendly interface in relation to other systems we are already using". "I will pick difficult usage for more effective results". "It should be supportive of the local language, easy to access, and have a clear manual".

5. Discussion

The section presents a detailed discussion of the themes identified in the thematic analysis. The discussion presents the different perceptions of the respondents as well as similar findings from the literature.

Furthermore, using NVIVO plus a word frequency, all 30 transcripts were used to generate a word cloud, as shown in Figure 4.

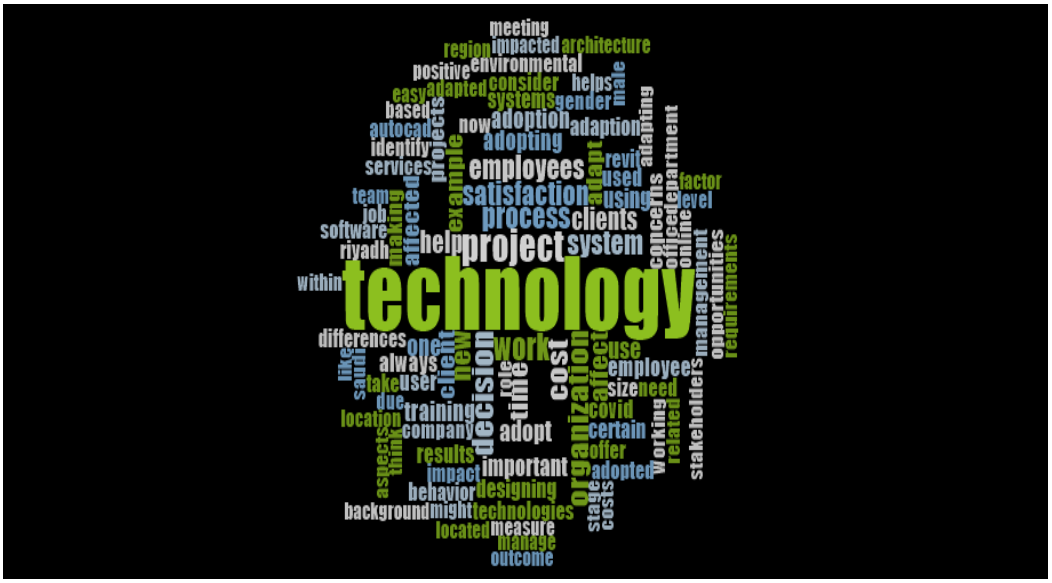

Figure 4. Interviews Word Cloud.

The font size of the words indicates the words that appear most frequently, the larger the font, the more the word appears in the interview transcripts. The word technology is the most frequent, which shows that the respondents understood and were well-versed in the concept of technology in architecture. The word cloud visualizes the respondent's feelings towards the concepts in the word cloud. Most of the concepts were also seen to appear often during the discussion of the themes.

5.1. Role of Gender in Technology Adoption

It is important to note that the descriptive results indicated that while the architecture industry was male-dominated, few females in the industry were more open to adopting different technology than their male counterparts. However, the limited number of female participants did not allow for a conclusive answer to be reached. The interviews, however, revealed that managers had mixed feelings about the influence of gender on technology adoption. Further, the interview offered more insight into the male dominance in the industry, pointing out that the number of females in the organization was still minimal. Several participants noted that in their organization, it did not matter if users were male or female when adopting technology, but rather, the technology attributes played a bigger role.

Participant (001) noted, "There is no difference in technology adoption between the genders, but other factors not related to the gender of the user". Participant (002) also recognized that gender did not influence technology adoption. "No, there is no difference between genders, but there is a generational gap among employees". The oldest employee in my company is 51 years old, and the youngest is 25. "I have noticed young employees always accept and utilize the technology, regardless of gender". On the other hand, some of the participants had differing opinions, as they felt that, in some cases, females were better at adapting to technology. The results also indicated that females in administrative positions in the organization were better and more advanced in terms of technology adoption than

their male counterparts in the organization. This is better illustrated by the responses from the respondents (003 and 018, respectively). Respondent (003). "Both genders accept adapting technology, but females are more familiar with the technology". Let me categorize them into two groups: architects and administrators. "For example, when we were setting up a training plan for our staff, the internal design chairman talked to me about how some of the male staff's level is weak in Microsoft, unlike the female, who was evaluated as advanced in using Microsoft basics". Respondent (018). Both genders can utilize technology. However, females' achievements are likely to be greater than males', and they can be more precise based on age. As noted in the descriptive data analysis, the number of females in the overall survey was limited, which can be explained by the male dominance of the industry. This is backed up by the findings from the interview, where respondents pointed out that they have a significantly lower number of employees in their organizations, as evidenced by the respondent (015). "I think there is no difference". "We have a limited number of female employees, or they could not exist in our maintenance and operations department". The respondent viewpoints resonate with the focal concern that technology adoption has no boundaries in terms of gender differences, but rather the initiative to embrace the use of technology by both females and males regardless of the age of the company's professionals. As outlined by the respondent, gender differences do not play a significant role in technology adoption since the nature of service provision relies on the mentality and the ability of a professional to use new and advanced technologies. Stakeholders play an essential role in influencing technology adoption [53]. For instance, the respondent denotes the fact that the level of awareness of the essentiality of technology by the stakeholders is the guiding principle for adopting new technologies in a construction company [49].

Both genders need to utilize technology, and this is guided by the focal concern of avoiding customer bias in the market based on the nature of the targeted clients in the market. The respondent affirms that the end-user plays a major role in impacting the decision process to adopt technologies. The end-user is the target market and a key stakeholder, and this means that the type of technology chosen needs to suit the interests and expectations of the targeted clients in the market. The respondent's viewpoints affirm that gender bias is a major concern with regard to technology adoption, as evident in other research [54]. According to Gebre [55], gender bias is not only evident in the construction industry, as evidenced by the interview results, but also in other industries, such as agriculture. However, most construction companies have an obligation to engage an equal number of females and males in the use and application of software and advanced technologies in a bid to evade issues that are founded on gender bias in the current market. The respondent outlines the reasoning that the gender barrier should not be considered a concern that needs to influence technology adoption since both males and females are equally capable of influencing the performance of an organization through technology adoption. However, some respondents, such as respondent 010, affirm that "males specialized in architecture, so they are more familiar with Revit, while females specialize in interior design, so they are more familiar with 3D Max, AutoCAD, and Sketchup". Particularly, the inclusion of females in technology adoption decisions is performance-based, which further suggests the scrutiny and reluctance directed toward a female in the industry [56]. For instance, the respondent reported that "at the beginning, when females joined the field, they did not rely on them in decision-making, but by the time female achievements were witnessed, they started to be given the chance to share in decision-making". The perception of the study respondent regarding the concept of gender and technology adoption embraced the need to focus on the mindset and level of professional competence of an individual rather than the concern of gender differences. For instance, the respondent denoted that "There is no relation between gender and technology adaption". It depends on scale and the person's experience. "As females recently joined the field in SA, they only need more time to gain the required skills".

5.2. Influence of Firm Size on Technology Adoption

While it was not the major aim of the research, the survey required respondents to indicate the size of their firm. The data would allow for data triangulation to be achieved by comparing results across different firm sizes. Previously, in the quantitative analysis, different firm size results were compared, such as small and large firms. Large firms considered factors affecting technology adoption as significant. The findings of the qualitative analysis agree with the quantitative findings. However, more information was gathered, with large firms emerging as quicker adopters due to their huge resource bases as opposed to small firms. According to the results of the survey, it was evident that small firms were more dominant in the Saudi Arabian architecture industry. However, from the survey, it was not possible to arrive at a conclusion as to which firms were better at adopting technology. The interview, therefore, asked more in-depth questions to allow for a better understanding of the influence of firm size on technology adoption.

Respondents felt that the adoption of technology in large and very large organizations was often derailed by the too often bureaucratic process. Numerous procedures involving authorization and approvals were required before the management could arrive at a decision to adopt a particular technology. In some cases, the technology was not adopted due to the bureaucracy, as illustrated by the respondent (015). According to Val Busaidi et al. [57], the process of decision-making, as the organization gets larger the process of taking decision gets more complicated and bureaucratic. To adapt a new system, you have to pass through a long administrative process and take multiple approvals until you reach the final approver. When it comes to decision-making small firms are better at making prompt decisions to adopt technology as there are fewer requirements. A relationship between firm size and the cost of technology was affirmed. Firms have to consider the benefits they accrue or a high-cost investment in technology, as evidenced by some of the responses from individuals in small firms, as evidenced by the respondent (001), "In terms of company size, it will be easy to adopt technology; for example, now we are discussing the idea of applying a new system that will facilitate the process of project supervision. Some technology might be expensive, such as admin systems, which I think should be utilized based on the institution's manpower capacity".

Based on the findings of the quantitative analysis and cross-validation through the interview, it appears that small firms are better at adopting technology but are faced with high-cost limitations, as noted in a study performed by Chege and Wang [58]. On the other hand, large firms, regardless of the availability of resources, were not good and fast adopters due to increased red tape in the organizations. The thought of the respondent is intended to justify the fact that the size of a firm does not contribute to the objective of technology adoption since both small and large-scale institutions require technology to improve and maintain quality performance. For example, respondent "The respondent believes that the size of technology impacts the process of technology adoption". For instance, the respondent affirms that "the more workload and manpower capacity you have, the more advanced technology you need". In this connection, it is imperative to acknowledge the sense of perception that a large organization requires advanced software for reducing the timelines for the workload and improving the level of productivity of services in the market. Given the viewpoints of the respondent, it is imperative to note that the size of an organization directly impacts technology adoption since as the number of employees increases, the need to adopt new technologies also increases. The perceptions of the respondent outline that the size of an organization impacts the process of technology adoption since as the number of employees increases, the need to adopt new and more technologies also increases.

The size of an organization defines the type and nature of technologies that would be applied in the quest of establishing sustainable buildings in the market [59]. According to some respondents, they were not able to adopt advanced technologies during COVID-19 based on their concerns regarding the size of the firm and the high cost of advanced technologies in the architectural field. Hence, it is imperative to support the

focal objective that a large organization would need to adopt technologies for improving efficiency and the effectiveness of its operations in the market. Given the viewpoints of the respondent regarding the need to adopt new technology based on the size of the firm, it is quite categorical to note that the use of computerization is intended to promote and improve digitalization in the construction and architecture fields [60]. Hence, the focus on affirming the essentiality of result-oriented factors such as demonstrability relies on the effective and accurate adoption of digital technology in the field of construction management. The respondent affirms that "the fewer the employees, the easier the adaptation of technology". The viewpoint of the respondent resonates with the results of the study, which affirm that the size of an organization directly impacts the process of technology adoption.

5.3. Types of Cost in Technology Adoption

According to Darko et al. [61], the cost is one of the major factors in technology adoption. However, various organizations will consider different types of costs often classified under three categories: fixed costs, variable costs, and benefit costs. The findings of the interview align with the findings of the quantitative research by identifying cost as having a significant impact on technology adoption decisions in organizations. Various managers who were interviewed agreed that they often considered the costs associated with technology before adopting it to determine the organization's capacity to adopt and use the technology. According to the manager respondent (008), the most important thing is that the cost of the technology is affordable, and then we can adapt once the scale of our employees increases. Another respondent manager (007) concurred with the fact that cost is a key factor in technology adoption decisions as noted below. *"Cost is the most important factor after the office efficiency and development. 1B. I will choose the system customized for rendering, and I will take the cost into consideration".* Some of the variable costs identified in the interview included operational costs such as license costs. The fixed cost included the cost of purchasing the software. For example, the respondent (008) identified that they consider the costs of software and often look for cheaper alternatives. *"For example, when Microsoft Office increased its cost, we looked for an alternative and we are now using "Labra Office"".* Benefit costs are often the benefits associated with making a decision minus the cost of making the decision. Some managers felt that the revenues from technical production were often more important in assessing the decision to adopt a technology or not than the initial cost, as they would often compensate for the initial cost through increased revenues.

As a result, the respondent's thoughts acknowledge the fact that technology adoption has enabled the company to maintain a consistent level of performance since employees can engage clients via the online platform. The respondent believes that the choice of cost-effective technologies is incremental to improving the performance of the organization, and this outlines the focus to use different technologies, such as EVIT and AUTOCAD. The objective of adopting new technology directly affects the overall project outcome, and based on the facts presented by the respondent, technology adoption improves the level of accuracy and reduces the cost of a construction project [62]. The cost of adopting technology plays an essential role in determining the types of technologies that are used by organizations. According to the respondent, they were not able to adopt advanced technologies during COVID-19 because of the high cost of advanced technologies in the architectural field. The operational cost needs to be considered as the major type of cost that needs to be considered before adopting technologies since it covers the overall cost of initiating and executing an entire project. For example, respondent 011 noted that "the most important thing is for the cost of the technology to be affordable, then we can adapt once the scale of our employees increases".

Hence, it is imperative to acknowledge the fact that the consideration of cost-effective technologies in the construction and architectural industries is quite essential for reducing the number of tasks associated with the identification and keeping records of project

deliverables. The respondent indicated that the identification of the right technology at the initial stages of project execution contributes to reducing the overall costs of constructing a building. Hence, it is imperative to acknowledge the fact that the consideration of cost-effective technologies in the construction and architectural industries is quite essential for reducing the number of tasks associated with the identification and keeping records of project deliverables. In this connection, the interview results were consistent with the study findings in the quantitative study, which were based on the fact that the use of advanced and cost-effective technologies plays an essential role in reducing the quantity of building materials used in the construction fields. Hence, the focus on building safe and low-cost housing through the use and application of new technology is intended to eradicate incidences where the owner has to undergo huge maintenance costs.

The perception of the respondents outlines the fact that the key stakeholders who take part in the technology adoption process focus on cost considerations and the reliability of the type of technology considered for the study. In this connection, it is imperative to justify the focal objective that the advancement of technology could prove quite effective in enabling the key professionals in the construction and architectural industries to gain access to digital information and promote learning for reasons of improving their level of productivity while executing their professional duties [63]. As a result, the perceived usefulness of digital technology would derive clients' satisfaction based on the level of advantage gained by enabling professionals in the construction industry to access and learn about the advanced technology in the construction industry. The viewpoints of the respondent outlined the fact that the focus on conducting a cost-benefit analysis is one of the key factors that justifies the level of acceptance of technology adoption by the targeted clients in the market. In this context, it is accurate to connect the thoughts of the respondent with the study findings [64,65] that affirmed the fact that a significant percentage of construction companies and targeted clients in the market are quite sensitive about the cost of designing and constructing sustainable buildings through the use and adoption of technology.

5.4. Technology's Ability to Produce Desired Results

Technology's ability to produce desired results was considered very important. Quality and presentation of the end product were recognized as paramount, as evidenced by one of the responses illustrated below: *"At present, we do not need new technology because we are using the top technology on the market that allows us to deliver results". "Revit helps to facilitate the coordination with all the members and to give early indicators using 3D Max to present high-quality images that we can present to the clients".* The company embraces the use of technology as the key platform of communication between clients, employees, and executive management [66]. As a result, the respondent's thoughts acknowledge the fact that technology adoption has enabled the company to maintain a consistent level of performance since employees can engage clients via the online platform. As indicated in the respondent example below, *"I do not need to call the tiling worker to find out the percentage of progress; I only set up a daily target progress of, for example, 40 slabs per day". "Then I can measure productivity. It also helps to show the client the effort and milestones achieved; I divided the project into tasks, and the client participates in watching the daily progress of the project".*

Given the nature of the response presented by the respondent regarding the context of brief preparations, it is important to note the fact that a significant percentage of the targeted clients in the construction industry are sensitive about the cost of running and completing the entire project. As a result, it is important to note that brief preparation needs to be accorded the requisite attention since it presents a clear and distinctive picture of project deliverables in terms of cost-effectiveness and the level of safety to the targeted clients in the market. Hence, the focus on affirming the essentiality of result-oriented factors, such as demonstrability relies on the effective and accurate adoption of digital technology in the field of construction management. The respondent's viewpoints align themselves with the study findings that demystify the fact that the client's needs should be

considered a key pillar that supports the successful execution and completion of projects in the construction industry [60]. Hence, it comes out quite categorically to defend the sense of perception that the technology adoption is a key element of result-oriented factors since it prevents a detailed outline of a project's deliverables and requirements that are needed to work on the project to the completion stage.

5.5. Brief Preparation and Its Role in Communication Media in Technology Adoption Process

The adoption and use of technology in brief preparation are challenged by the lack of specialized technology to aid the process. Some organizations adopt technologies that are the result of research and design. More organizations consider brief preparation to be a very important stage and thus would adopt any technology that would make the process more efficient, for both the organization and the client as illustrated below.

"We achieve the briefing stage manually; we are not using any technology for briefing because 90% of our clients prefer physical meetings in our office, and we prefer hosting our clients to gain their trust. However, if there is any effective technology that will help increase the efficiency of the office, we will not hesitate to adapt it".

"We use manuals and some software, such as a spreadsheet". "Therefore, we are using technology at this stage for searching and investigation during the preparation of the briefing".

Given the question regarding how technology helps in the preparation of the briefs, the professional opinion of the respondent proved effective based on his level of awareness regarding the essentiality of drafting a conclusive project deliverable at the brief preparation stage. For instance, respondent 013 asserts that "preparing a brief is the first product to be shown to the clients, so it should be conducted based on the client's background; if he is specialized, we show him numbers and lines, but if he is not specialized, we used to show him a tangible presentation". As a result, it is imperative to acknowledge the fact that brief preparation focuses on the interests and level of satisfaction of the end-users [66]. In another response, the respondent indicated the importance of the stage on brief preparation, outlining some digital technologies they employ as illustrated below:

"Preparing the brief is the first product to be shown to the clients, so it should be conducted based on the client's background; if he is specialized, we show him numbers and lines, but if he is not specialized, we used to show him tangible presentation". "We call this stage gathering client requirements (data gathering)". "We conduct meetings with the clients, including representatives of each department with the project manager, to show him previous work and present our suggestions after the client's approval". "This is essential work for the project, and we are not enough with one meeting; sometimes we conduct four meetings; we suggest some additions and improvements; then we make the design requirements; and then we get client approval on the state of work". "We use visualization tools such as Photoshop, animation tools, virtual meeting tools, and predesign tools such as BIM, but at the end, we conduct the brief manual on a word file, including specified requirements and states".

As such, a brief preparation stage needs to be considered as a core underlying factor that determines the level of reliability of executing a highly sustainable building project. The respondent defended the fact that brief preparation needs to be considered an essential factor for driving positive results based on the reasoning that it lays out a platform for creating a formal contract between a construction firm and its targeted clients.

5.6. Project Attributes Considered in Technology Adoption

Respondents felt the need to test the influence of technology on project time before adopting it. Technologies that made the project more efficient by providing time-saving opportunities were preferred as they trickled down to cost-saving. For example, participants noted that they performed tests on technology before purchasing it, as one participant noted. "*By applying a demo or very extensive workshop, we test resource management and the efficiency of client management to determine if the project improves time*". The objective of adopting new technology directly affects the overall project outcome, and based on the facts presented by the respondent, technology adoption improves the level of accuracy and reduces the cost

of a construction project [67]. The impact on project outcomes is best explained in one of the respondent's examples: *"Technology is a tool to facilitate and expedite the work". "It also helps to overcome obstacles".* For example, in 2020, in the process of replacing AutoCAD with the BIM system for designing, which includes more details, we will have a specialized, trained team. BIM System opened the scale with international companies and competition with international companies. In SA, we applied the BIM system to the NEOM project, and we won a reward. Additionally, the respondent's perceptions defended the fact that the use and application of technology in the construction sector contribute towards reducing the time that could be wasted in keeping and maintaining records of project deliverables. Given the nature of the response presented by the study participant, it is imperative to note that technological adoption needs to be considered in building sustainable architectural work based on the objective that it reduces the time associated with establishing sustainable buildings in modern society [68].

5.7. Ability to Improve Services Provided

Interviewers let that technology affect the services they offered positively, so it was necessary to consider this before adopting a technology. The quality of services improved, resulting in positive feedback and referrals from clients. The organization also needed to maintain the level of good services regardless of any shifts in operations, as indicated by an example from one of the interviewees.

"Technology has always given us positive feedback on our services". "We were working with the governmental sector, and we are under a lot of pressure during the process of transferring to the private sector". "We had to adapt new technologies and strategies to cope with that transition and reach the target level".

The opinions presented by the respondent defended the fact that the initiative of offering standard services and completing the project on time defines the service-oriented factors [69]. Hence, it is quite categorical to acknowledge that the core reasoning behind offering and maintaining quality service in the building and construction industry dwells on the focal concern of adopting technologies that aid in the provision of sustainable and efficient services. The professional competence of the respondent defends the objective of adopting building information models as a key pillar that supports quality service provision in the construction sector.

As outlined by the respondent, gender differences do not play a significant role in technology adoption since the nature of service provision relies on the mentality and the ability of a professional to use new and advanced technologies. The viewpoints of the respondent supported the fact that the consideration of advanced technologies proves quite effective since they give construction companies the advantage of adhering to the highest level of accuracy, particularly in terms of outlining the key project deliverables and requirements. The viewpoint of the respondent proves quite effective by defending the perception that the type of technology adopted by an organization affects the nature of services offered by the construction firm in the market by 100%. For instance, respondent 012 asserted that Revit software plays an essential role in improving the overall quality of drawing and avoiding graphing quality issues.

5.8. Environmental Factor at the Core of Technology Adoption

Environmental considerations were a key factor to consider in technology adoption [70]. However, the awareness of the existence of technology that can aid in environmental optimizations seems to present a challenge in the adoption of technology [1,2,9,71,72]. Technology helped in optimizing aspects of weather control and developing sustainable and environmentally friendly organizations as in the case presented. "We prioritize environmentally friendly factors; for example, when we were working on the NEOM village, we took into consideration sun direction, solar energy, and other aspects too". "We concentrate on surrounding environment analysis in a huge project that might affect nature and wildlife, and we focus on weather impact analysis".

The focus on environmental considerations makes the perspectives of the respondent valid, and this is guided by the theoretical framework to establish green building technologies. The respondent affirms that "we are concerned with the water and electricity consumption and have sought direction and lightening positions from the subconsultant team". In this connection, the respondent indicates that the environmental concerns they consider before adopting new technologies include the level of water and electrical consumption. Given the perception of environmental considerations, the perception of respondents affirmed that the consideration of the most cost-effective technologies in the building and construction industry is not only intended to reduce the cost of construction but also the need to construct buildings that adhere to safe environmental considerations. Given the concern regarding environmental considerations, the perspective of the respondent proved consistent with the quantitative analysis of the study that outlined the fact that the focus on adopting eco-friendly construction technologies needs to be considered as one of the most cost-effective approaches to constructing sustainable buildings in the market.

5.9. Training as Incremental in Technology Adoption Decisions

Training concerns before adopting technology presented in the interview included trainees' resistance, trainee expertise and skills, and training costs [62]. The interviewee noted that some of the employees rejected the training, as some of them considered it an obstacle and burden. In other cases, employees did not have the skills needed to utilize the adopted technology, which resulted in the additional cost of training that was often budgeted as in the example below. "In the process of adapting the system to 2D instead of 3D, we have encouraged the staff to learn on Revit, but some of them attend the training and they do not know how to use it". "Overtime training gives the company an additional cost".

The respondent acknowledges the need to train employees on using different technologies as a technique of maintaining clients' loyalty and keeping new clients who may require the application of advanced technologies in the architectural fields. Given the nature of perspectives shared by the respondent, it is evident to denote the fact that if construction companies invest in training their professionals to learn to use advanced technologies, then they would stand a better chance of meeting the expectations and the interests of their targeted clients in the market [33]. Based on the concerns highlighted by the respondent, it is important to note that the majority of the construction firms in the building industry are reluctant to engage their employees in training based on the focal concern that the time and cost of offering training to the professionals engaged by such construction firms. The readiness of employees to learn to use new and advanced technology is improving their level of productivity and reliability in the workspace. For example, respondent 007 outlined that "the main problem is we always have no training and the employees depend on self-learning". "In this context, it is imperative to note that the initiative taken by an organization enhance user-friendliness with new technologies adopted by an organization would play an essential role in improving the overall quality of a construction project".

5.10. User-Friendliness Enhances Technology Adoption

User-friendliness, on the other hand, came out as a factor that most organizations considered essential when adopting technology. Aspects of concern included friendly interfaces, easy access, and easy usage. However, there were cases where ease of use was not considered an important factor. For example, in cases where the desired result could only be achieved using a technology that was difficult to understand. In such cases, some organizations would rather invest in adopting and acquiring skills to use difficult technology. The features of the technologies chosen play an essential role in affecting the overall outcome of a project. For instance, the respondent denotes that "many of the Saudi organizations that have turned to the BM have had to run the AutoCAD department at the same time to keep up with the local market, which causes redundancy and duplication". Hence, it is becoming clearer that the intended outcome regarding the types of technology

adopted plays an essential role in determining the overall sustainability of using and applying different types of technologies.

5.11. User Satisfaction Accelerates Technology Adoption

For instance, the respondent proves quite conclusive by outlining the fact that the need to engage the end-user on the perceived usefulness of technology by an organization plays an essential role in deriving their overall satisfaction about the perceived usefulness of technology in the building and construction industry. The employees' level of satisfaction affects the technology adoption process by a significant percentage. The professional intellects shared by the respondent revealed that the consideration of factors such as training skills, end-user intentions to accept technologies, and the willingness of the construction organizations to walk them through the training process is an essential factor that determines the level of perceived usefulness of technologies in the construction sector. Hence, it is consistent to connect the respondents' viewpoints to the analysis of the study findings to identify the fact that the initiative of attaining success through technology adoption dwells on the level of resilience, particularly based on how the employees engaged by an organization would stay productive and effective while offering their professional services through the use and application of advanced technologies. The professional opinions presented by the study respondent defended the analysis of the study findings and embraced the objective of delivering quality and standard services in the market as the epitome of deriving the highest level of client satisfaction in the market [69]. The respondent acknowledged the fact that the perceived usefulness of technology is defined by the nature of services guaranteed by the architectural and construction companies in the market.

5.12. Relationship between Technology Adoption and Client Satisfaction

The respondent's viewpoints regarding concern for a client's satisfaction are consistent with the perception that the expectation of a client is an essential aspect that sets the foundation for guaranteeing results-oriented factors. In this context, the focus on sharing the plans and the relevance of the project with clients and the local authorities is intended to justify the project's success or failure during the execution process. In this connection, it comes out that the need to share with the clients the advantages and benefits that come with adopting new and advanced technologies in the construction industry is an incremental aspect of improving the level of satisfaction of the targeted clients in the market. The results affirm that the client plays a major role in impacting the decision process to adopt technologies. The client is the target market and a key stakeholder, and this means that the type of technology chosen needs to suit the interests and expectations of the targeted clients in the market. Hence, the focus on contextualizing key tenets of work specialization based on the types of software and technological advancement applied by organizations could derive the level of client satisfaction, particularly based on the perceived usefulness of technology. Given the nature of the response presented by the respondent regarding the context of brief preparations, it is important to note the fact that a significant percentage of the targeted clients in the construction industry are sensitive about the cost of running and completing the entire project. The initiative for construction companies to work within the means of their targeted clients by adhering to costs and safety measures is a key factor for attaining quality service provision and meeting the expectations of the targeted clients in the market [27]. Hence, the thought of the respondent suggests that the consideration of essential provisions of project execution, such as ease of access, location, and safety procedures, proves to be highly significant in deriving the level of satisfaction of the targeted client in the market. As a result, the clients would have a comprehensive understanding of the nature of work protocols that would be accorded the requisite attention in a bid to design and establish sustainable buildings that adhere to environmental considerations and guidelines. In this connection, the targeted clients in the market are more likely to consider technology to be essential, particularly in circumstances in which they have the platform to anticipate the usefulness of technology and focus on attaining positive results.

Given the roles and the capacities of key stakeholders engaged by construction companies, the viewpoints of the respondent confirmed the fact that the objective of using innovative techniques, such as the use of software, in the architectural industry proves effective for improving the level of effectiveness in establishing sustainable buildings. Hence, the level of satisfaction from both the clients and the construction companies would be attained based on the perception that technology would be safe and highly sustainable. Consequently, the viewpoints of the respondent denoted the focal objective that the focus on attaining the desired level of customer satisfaction is embedded in an accurate choice of technologies that align themselves with safety procedures while incurring the lowest cost throughout the project execution process. The feedback and results of the respondents engaged in the study affirmed that the income and financial capacities of the targeted clients in the market are determinant factors in assessing the perceived acceptance of technology adoption in the construction industries. Hence, it is imperative to note that a significant percentage of the targeted clients in the market who are cost-sensitive would consider accepting technologies that would reduce the cost of purchasing building materials [73]. The viewpoints of the respondent regarding the perception of clients' satisfaction echoed the concern that the majority of the targeted clients in the construction and architecture industries would accept technology adoption for reasons of guaranteeing the safety and security of their residents.

5.13. Decision-Making and How It Affects the Adoption of Technology

Every organization's setup necessitates the ability to make decisions. It consists of identifying and deciding on alternative options that result in the desired result. The field of decision-making is not well understood [74]. Workers at all organizational levels make a range of judgments based on the data they acquire. These choices have the power to affect the lives of others and change the course of an organization. As an example, an interviewee pointed out that when applying for anything, a client suggestion is analyzed and considered to be viable or not before being implemented. Habitual decisions are also common in the organizational structure of most companies in Kingdom of Saudi Arabia KSA [75]. Many firms, for example, deal with client complaints daily. Because grievances are a common occurrence, reacting to them becomes a habit. The establishment may implement a policy that states that every time a valid customer complaint is received, the consumer gets a discount, and this is regarded as a decision rule. A unique and essential decision, on the other hand, necessitates intentional thinking, information collection, and a serious examination of alternatives, as said in one of the interviews. The respondent shared the perception that managers come out as the sole decision-makers regarding the need to adopt technologies. For instance, the respondent mentioned that "managers perform a simple calculation instead of having 100 people in the office, they let only 25% of them attend and the rest work from home, which reduces the wage and saves money for the company". Hence, the availability of technology is deemed effective in supporting the initiative to engage professionals remotely and through the online platform.

Decisions can be classified into three categories based on the extent to which they occur. Business strategies influence the vision of the company. Tactical choices have an impact on the way things are conducted. Finally, management plans are the daily choices made by employees to keep the business running. For example, a case scenario is given in one of the interviews: "Let us assume we are applying AutoCAD, and one of the clients we sign a contract with wants to use Revit". "We arose this during the meeting agenda: we need to purchase Revit and train two of our employees, or we can lose that client. Then the investor requested to use Revit, and we discussed his request at the level of the company and client interest". Based on the example mentioned above, the overall outcome of the project was less satisfactory for the management or organization side as service providers. This was due to the fact that it took time for the team to familiarize themselves and adapt to the new program EVIT, resulting in some loss of professionalism that the company usually provides. However, despite these challenges, the client was satisfied with the final outcome and received what they wanted. This can be classified as a tactical decision. In arriving

at tactical decisions organizations make use of a rational decision-making model, which entails eight steps among them.

1. The identification of the problem,
2. Formation of the decision criteria
3. Evaluating the decision criteria
4. Generation of alternatives
5. Evaluation of the alternatives
6. Choosing the best alternatives
7. Implementing the decision
8. Evaluating the decision

Although decision-makers can stray within some of these processes, research suggests that the fourth step, searching for alternatives, is by far the most difficult and frequently results in failure. In fact, one of the interviews showed that in the adoption of technology, no alternative generation occurred. It is important to note that organizations that have been successful understood what they wanted from the beginning of the decision-making process, established goals for others to respond to, conducted an unconstrained search for solutions, enlisted the help of key individuals, and avoided using their position to force their viewpoint.

Decision-makers can learn a lot from the rational decision-making paradigm. First and foremost, while making a decision, it is clear from the interview that one has to make sure the decision criteria are defined before looking for alternatives. This helps keep one from falling in love with one option and narrowing the criteria as a result. Setting criteria before looking for alternatives can help you avoid making mistakes. Another benefit of a rational model would be that it encourages decision-makers to consider all options rather than just a few. It is unlikely for one to make a much more effective decision that does not require compromising one criterion just for another if they generate a large number of alternatives that span a lot of possibilities.

Despite the numerous benefits, it is important to note that there are several implausible assumptions in the model. It implies that people are fully aware of the decision at hand, that they are aware of all their options, that they are free of perceptual biases, and that they desire to make the best decision possible. Whereas the rational decision-making model could be useful in assisting decision-makers when navigating challenges, it does not represent how decisions are commonly made within organizations.

For example, this model suggests that we should consider all available options before making a decision, but this is a time-consuming process, and people are frequently under pressure to make decisions. Furthermore, even if we had access to all available information, weighing the benefits and drawbacks of each option and ranking them according to our preferences could be difficult. In fact, having too much information available might lead to "analysis paralysis", as more and more time is spent obtaining and analyzing data. For example, when looking to adopt a technology, a company may invest a great deal of time and resources to find a suitable one, which may be counterproductive. Time and cost of the process are two paramount factors to be considered when utilizing certain technology. The purchasing and operations functions serve as the most important. From the interviews, it is clear that most organizations in KSA are willing to utilize new technology if it offers solutions like the one achieved in the example above.

6. Emerging Themes from the Discussion

6.1. Outsourcing and Its Benefits in Architecture

Outsourcing happens when one company reaches an agreement with another to perform a task or be responsible for a certain activity on its behalf to reduce costs. In architecture, this could include services at various stages of the architectural process, such as the development of drawings such as plans and elevations, interior design documentation, shop drawings, MEP documentation, facility management documentation, and construction documentation. Findings from the interview cite that some of the managers

opted to adopt the technology by outsourcing it rather than buying it as a way of reducing associated costs. Klochko [76] asserts that one major benefit of outsourcing is improving efficiency, as the firm can opt to outsource smaller activities to other firms that specifically specialize in those tasks. This means that the firm can complete a single project faster since it divides the work while simultaneously ensuring higher overall quality. The improved speed and quality of work result in an overall increase in the efficiency of the process. In addition, outsourcing creates time to do other tasks by letting firms delegate work to others for a fraction of the cost. Ultimately, outsourcing creates savings in time and money, with the capacity to save on architectural costs [76]. The adoption of 3D technology in modeling has provided architects with a level of interaction previously unforeseen in their work. VR technology is also expanding the possibilities of the profession, enabling architects to create renders and allowing clients to experience products beforehand. However, there has been resistance to the adoption of technology and general change by architects. Austin [77] documents the tendency for architects to stick to historical models and the means of their development, resulting in a phenomenon he terms "archaeologism". In addition, he decries the tendency of architectural pedagogy to focus on the past with little construction. The time freed can then be channeled into other activities that are the strength of the hiring firm, while the money saved goes on to improve the profit margins.

Aside from the factors that make the process more efficient, outsourcing also makes the result more appealing. state that when a firm outsources, they are outsourcing external talent. This means that the company pays for talent, which they do not have to maintain on a paid basis. This enables the firm to pull in creativity from external sources. Ultimately, clients benefit from an external perspective that ensures novelty in a firm's output. Once a firm can post a motley portfolio, it can attract clients from a wider field due to the difference between general designs and futuristic concepts [78]. This is a positive outcome for any firm as it enables them to build their reputation as a versatile firm, and they can thus satisfy jobs for a variety of clients who may be willing to pay more for a rarer service. Outsourcing has been popularized using technology, which is mostly the preserve of younger generations. Fountain [79] posits that this brings flexibility and new ideas to the industry, as then architecture can operate to suit a 24-h economy, unlike in the past when the opening and closing times of the firms dictated when work could be conducted.

6.2. Resistance as a Barrier to Adoption of Technology in Architecture

With the advent of technology, architecture has given attention to the appreciation of technology and prospects in the field. In addition, the world has begun its journey towards sustainability, and buildings must adopt sustainable designs to contribute to the fight against global warming and climate change, if not to insulate their inhabitants from the adverse effects of these phenomena. According to [80], one of the crucial factors in creating sustainable architecture is the selection of ecological materials. This sustainable technology is, however, costly and difficult to work with due to its specific requirements. Thus, architects prefer to remain within their comfort zones rather than adopt new technology.

The most celebrated pioneers of the profession also contribute in some way to the resistance to change. The most prominent architects now have been in the field for decades and have had the opportunity to practice their craft using the skills they learned in their youth but have not seized the opportunity to update their skill set. Consequently, the style of architecture being idolized utilizes the same thoughts, patterns, and technologies as in the past, creating a feedback loop that is hard to break. This induces a cognitive bias in the field and leads one to maintain the status quo at the cost of pursuing innovation and change [81]. These sentiments are echoed by [82], who reveals that one of the main showstoppers is the maintenance of the status quo. Ultimately, the field seems to be experiencing teething problems in the adoption of technology, but the opposition from this current is not insurmountable. Ayinla [83] posits that the gradual development and sophistication of the technology will continue to outdo all other past methods until it

emerges as the outright winner for the best tool or graduates from trend to practice if no proactive measures are taken.

6.3. Impact of COVID-19 on Technology Adoption

The COVID-19 pandemic wreaked havoc on all sectors of life. The architectural field was also affected by the incidence of the virus, with gaping differences in the processes that architects are employing currently as opposed to the time before. Haley problematizes the pre-COVID-19 architecture as focused on aesthetics and specialized function, something that was rather practical given the dynamics of the time. Buildings could save space, even if it meant keeping individuals in very close contact with each other. However, this could no longer work given the workings of the coronavirus and the safety measures necessary to continue with basic societal functions such as work and staying. This was the beginning of a revolution in architecture, which was previously rooted in old technology and adhered to the old ways of construction. However, Whalen [84] notes that circumstances had to change to ensure the safety of residents and dwellers on any premises. The demand for new, large-scale architecture was high and required immediate satisfaction. Normally, the average hospital has a build timeline of ten years from conception to completion, but a project in Wuhan, China, saw the completion of an entire hospital in a mere ten days [85]. The logarithmic reduction required prefabricated pieces to achieve this, signifying a shift from the natural process of building toward new technology that incorporates pre-fabrication. Hameed [86] also notes that the pandemic led to the embrace of sustainable, epidemic-resistant design, which requires more space and encourages the use of technologies geared toward sustainability. Hameed (2021) sees the pandemic as a gateway to new prospects in the building. In essence, the COVID-19 pandemic led to the increased uptake of technology in architecture, with an emphasis on designs and technology that reduced the chances of contracting the virus while simultaneously embracing sustainability. Disruptive issues such as COVID-19 and the financial crisis and how they impact the adoption of technology were also featured in the interviews, and the response among the interviewees was that most workplaces were less affected since they had already embraced technology in their workplaces. In some instances, some had already begun working from home way back before the advent of COVID-19.

COVID-19 has shaken the foundation of engagement within work setups. Many employees have been affected by the pandemic. Technology has proven handy in this perilous time. Emotional intelligence is an aspect of organizational behavior that entails the identification and management of one's emotions. Being emotionally intelligent entails emotional awareness, which involves recognizing one's emotions, possessing the mechanism to harness them, and incorporating them into tasks such as problem-solving and having the capability to control emotions. Emotional intelligence has gained full acceptance, leading to its incorporation in organization setups as a measure of proficiency. An emotionally intelligent individual is capable of discerning an emotional state and establishing a way of managing it. The COVID-19 situation has marked a challenging dispensation in organizations, with managers battling to sustain desired behavior, which has been difficult.

6.4. Emerging Technologies

Emerging technologies refer to technological advancements in a variety of areas. There is still a lot of room for advancement in these disciplines of innovation. The technologies can be identified by their capacity to expand quickly, have a significant influence, be coherent, and have a lot of uncertainty. Information technology, cognitive science, artificial intelligence, educational technologies, robotics, nanotechnology, psychotechnology, and biotechnology are all examples of emerging technologies (Rabbani, 2020). These advancements have an impact on our daily lives. They shape our health policies, have an impact on our natural environment, shape our social connections, and have a political impact. Their potential to influence the way we live and coexist with our ecology demonstrates how powerful they are.

Advances in the field of robotics are a fascinating phenomenon. The ability of machines to ease work and replicate human actions is captivating. Robotics is an emerging technology with an array of purposeful skills [75]. It presents an opportunity to revolutionize the engineering field. Currently, robotics has been applied in the military field to aid in defusing bombs, exploring mines, and even retrieving survivors in case of a catastrophic event such as an earthquake. They have been helpful because they are capable of taking on tasks in hazardous environments. It is exciting to note that as time goes on, humans will find robotics more useful. In the future, robotics will transform our way of life, impacting our health, economy, and defense. The mere thought of its impact on warfare is one primary reason why humanity should tread carefully in the field of robotics.

Artificial intelligence is an integral feature of emerging technologies, with transformation of machines to the level of displaying human intelligence [64]. Machines are capable of manifesting cognitive intelligence and mimicking emotional and social functions that are exhibited by humans. Artificial intelligence is evident in the continual progress of human sophistication but it comes with some risks. ed [64]. There will also be an emergence of ethical issues insofar as the rights of the machines are concerned. Nevertheless, if AI research is monitored, humanity stands to benefit from the unexpected benefits of this emerging technology.

With the resurgence of research in the field, it will not be long before our very existence is jeopardized by machines. We risk slipping into an economic crisis if AI advancement continues unabated [64]. The level of unemployment will potentially rise. There will also be an emergence of ethical issues insofar as the rights of the machines are concerned. Nevertheless, if AI research is monitored, humanity stands to benefit from the unexpected benefits of this emerging technology.

Nanotechnology is another emerging technology that has the potential to grow beyond our imagination. The influence of matter up to the supramolecular scale has opened up a wide range of applications when nanotechnology is put into context. Despite the numerous benefits nanotechnology brings, we are unfortunately exposed to many risks. Research states that genetically modified food and reproductive technologies, among other nanotechnologies, are hazardous to our health [87]. Therefore, Alamoudi and Abidoye [88] suggest that proper regulations should be used to limit the effects of nanotechnology; otherwise, humanity runs the risk of incurring huge losses compared to its benefits.

In the field of human development and health, psychotechnology is a fundamental subject. Inter-personal relationships have been known to affect overall personal growth. Emerging technologies have led to the development of devices that tend to take away the joy of interaction. Research shows that people spend more time with their phones and PCs than engaging in social activities. The propensity to embrace technology at the expense of other features of life is dangerous. Hypokinetic diseases that we have been forced to battle with are lifestyle diseases. It is proper for society to review the impact of innovation. Failure to do so will put humanity on the brink of extinction in the long run.

7. Conclusions

This study aimed to obtain a deeper understanding of the factors affecting digital technology adoption. The interviews were designed to capture the different perceptions of industry users regarding the extent to which factors affected technology adoption in architecture. The result of the interview validated most of the quantitative findings. However, new insights emerged, which are discussed under each of the themes. The major findings that validated the significance of the relationships are captured as follows:

1. The interview results confirmed that managers in the architecture field only adopted technologies that helped them achieve the results agreed upon by the firm and the client, as client satisfaction was an important aspect of ensuring a good reputation.
2. For all firms, ranging from small to large companies, cost and especially the ability of technology to result in cost savings for the company were equally important.

3. Technologies that helped the firm improve their service delivery to the clients were considered important and were more likely to be adopted.
4. The results confirmed that environmental sustainability and conservation were core goals for most managers, and they thus considered if technology in any way helped optimize the friendliness of architectural designs to the environment. It was also important that technology help improve the architecture's designs' resilience to changing environmental conditions.
5. There was a consensus among manager interviews that training costs were a major hindrance to technology adoption in architecture. Most managers confirmed that they only adopted technologies whose training considerations, such as training skills and training cost, were within the company's human and financial capacity.
6. There was also the validation that the user-friendliness of the technology interface drives its adoption, while user satisfaction accelerates the process of technology adoption.

The interview analysis resulted in a few findings related to the concept of technology adoption. The novel contribution of this qualitative phase included the emerging factors from discussion, such as

1. Outsourcing and its benefits are a new concept in technology adoption in architecture,
2. The impact of COVID-19 on technology adoption and use in architecture, and
3. The adoption of emerging technologies. These emerging issues were important as it was evident that the process of technology adoption is not static but rather evolving with time and technological advancement.

The findings on the place of gender in technology were not conclusive, necessitating the need for future research to study the role of gender in technology adoption. The responses from the interviews confirmed that some managers felt that it affected technology adoption because women were more open to change, while others felt that it did not matter. In other cases, the responses confirmed that women were open to the adoption of certain technologies as opposed to their male counterparts. These diverse responses raise the question of whether gender is a barrier, contributor, or factor influencing technology that needs to be answered by future research.

There was also an intersection between costs in general and training costs. Some managers covered the aspect of training costs when considering general costs as a factor influencing technology. Other responses covered training costs when describing training considerations before technology adoption. This raised a future research question on whether training cost needs to be treated as a variable or factor in future research or under the umbrella of cost or training considerations.

Overall, the qualitative data collection and analysis process achieved its aim of identifying seven factors that impact the technology adoption decision-making process at the management level in the architecture industry. These factors include demonstrability, cost, project time, environmental considerations, service quality, training costs, and user-friendliness. However, according to the respondents' perception, there was a general feeling that although brief preparation was an integral and important stage in a project, it did not necessarily influence technology adoption. Instead, it was used as a communication tool between the client and the architect.

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