Determinants of an effective digital transformation in construction organisations: A qualitative investigation

Abstract

Purpose: Digital uptake among construction organisations is described as slow and ineffective, undermining a fundamental transformation and limiting construction firms from exploiting the digital benefits. In this space, meaningful research that utilises a qualitative approach in pursuit of employees' insights towards digital transformation is lacking. Such limited focus from previous efforts presents an opportunity to illuminate the determinants of an effective digital transformation that are, arguably, responsible for the status quo of low digital uptake in the construction sector.

Design/methodology/approach: This study adopts a qualitative approach to address the literature's digital discreetness in construction. The qualitative approach captures employees' perspectives through its unbounded characteristic of encouraging illustration and discussion.

Findings: This paper captures 35 digital transformation determinants under three clusters, namely, organisation related; i.e. hierarchy, size, and management, people related; i.e. team orientation, training, and knowledge, and leadership related; i.e. awareness, attitude, approach, and leaders' characteristics. Findings suggest a new set of arguments in relation to understudied factors and their influence on the digital uptake in construction organisations.

Originality: This paper offers empirical indication of the determinants believed to influence an effective digital transformation in construction organisations. Such conceptualisation is crucial and is depicted as perceived by construction employees and practitioners, which is a less bias approach than that of comparable studies who argue the viewpoints of industry leaders in isolation of other members of the hierarchy.

1. Introduction

The magnitude of the construction industry ranks it as a prime sector at both local and global levels. The industry employs over 2.4 million individuals and is valued at over £100bn in the UK alone (Stiles et al., 2021), and over $10 trillion globally (Büchner, 2019). Nevertheless, its fragmented market influences less innovation adoption and more resistance to change (Ebekozien and Aigbavboa, 2021). Rather than embracing innovations and exploiting their myriad advantages; instead, the construction industry is reflecting a slow pace in this direction. While other industries excel due to digital transformation (Zhang, 2021), the construction industry undermines wider digital adoption (Opoku et al., 2021). The pace at which the industry is transforming towards digitalisation is counterproductive and summons an overarching understanding of the pressure points behind the slow uptake (Bademosi and Issa, 2021). Hence, there is a need to reveal the routes where a plausible and compelling digital transformation may support the industry's ability to address its modern challenges.

An effective digital transformation is associated with capturing value through automating tasks (Manzoor et al., 2021), minimising human error (Huang et al., 2021), and improving overall performance (Nikmehr et al., 2021). This paper responds to recent calls on the need to investigate the digital standing of construction organisations (Olawumi and Chan, 2018), beyond only the technical aspects (Ernstsen et al., 2021). Literature focuses on the barriers facing digitalisation among construction stakeholders like their caution to invest (Ebekozien and Aigbavboa, 2021), the learning curve needed (Helbig et al., 2021), and the unawareness of associated advantages (Durdyev et al., 2021). However, literature is discreet in reflecting a clear guide to determining an effective digital transformation among construction organisations (Bhattacharya and Momaya, 2021). Hence, meaningful research that would

conceptualise the key measurable determinants can act as a catalyst for overcoming the forces resisting change.

Generally, previous research efforts in construction have been tailored to focus on the barriers of digitalisation particularly related to cost considerations, the challenging learning curve, and the lack of awareness and knowledge. However, an exploration of the influence of these barriers and their critical role in determining the factors that can facilitate digitalisation in construction remains an understudied and timely topic. Through this exploration, the study aims to guide construction organisations to the determinants that can create the circumstances for digitalisation to effectively flourish, overcoming the barriers and fostering a digitally embracing work culture in the UK construction industry.

2. Literature review

Adopting digital technologies is associated with countless benefits that aid firms to excel and flourish. To start with, it is essential to distinguish the meaning behind the terms ‘digitisation’ and ‘digitalisation’. Digitisation is converting non-digital means to electronic means, e.g. papers to PDF files, while digitalisation is realising value from this conversion at a more advanced level (Gobble, 2018). The term ‘digital transformation refers to the organisational approach to realising and capturing the associated value to enhance their processes (Mergel et al., 2019). For instance, digitisation converses analogues of information into a digitally accessible and sharable setup of bits and bytes (Pedersen and Wilkinson, 2018). In contrast, digitalisation comprises digitisation with the integration of business processes towards realising value from the digital shift (Enhuber, 2015). Digitalisation is therefore a process that is described as a shift from the generic ways of realising value, varying from simple use of digital tools to also include more advanced approaches such as Building Information Modelling (Saad et al., 2022), Digital Twins (Musarat et al., 2021), Geographic

Information Systems (Shafiq and Afzal, 2020), Drones (Onososen et al., 2023), and 3D Printing (Agustí-Juan and Habert, 2017).

A transformation, as a result, means that a firm is expanding to adopt technologies not as a prospect of luxury but as a necessity for the organisation's survival (Venkitachalam and Schiuma, 2022). Studies on digital transformation focus on the associated technical and non-technical advantages and constraints. For instance, Ajwani-Ramchandani et al. (2021) depict digital transformation as aligned with achieving a circular economy through supporting critical waste reduction, while Trkman and Černe (2022) report that digitalisation goes concurrently with carbon reduction efforts, and Nikmehr et al. (2021) underscore the significance of digitalisation in enhancing organisational performance. These benefits are viewed from the lens of productivity (Hasan and Lu, 2021), promoting informed decisions in the construction context (Sujan et al., 2020). However, these benefits alone are not forming sufficient justifications to drive fundamental change (Lindquist, 2022). Hence, there is an increasing need to study the widespread use of digitalisation in isolation from its added value.

Despite the benefits of digitalisation in general, the adoption rate among construction organisations could be faster (Ernstsen et al., 2021). Limited studies highlight how an effective digital transformation could be achieved. Theoretically, it has been argued that to enhance an innovation's uptake among a specific social system, benefits and values alone may not drive an innovation-adoption (Rogers, 2003). Although benefits may shape a drive, determinants beyond what is perceived as technical and innovation-oriented may aid a digital transformation from within an organisation (Zulu and Khosrowshahi, 2021). Generally, scholars echo the complications and ambiguities behind driving innovations in the construction context

(Akinade et al., 2020; Çetin et al., 2021). This becomes even more evident with the lack of a rationale that justifies innovation adoption (Newton and Newman, 2015). Therefore, investigating digital transformation creates a foundation for construction organisations to facilitate new ideas and practices across their departments. This is achieved by providing the circumstances for an environment that encourages innovation, where innovation adoption in this narrative becomes the driving force for digital transformation in construction.

Scholars realise the understudied nature of digitalisation in the construction context, calling for comparable research. For instance, Prebanić and Vukomanović (2021) report, through a recent systematic review, the discreetly digitalised nature of the construction industry, calling research to explain and understand such social phenomenon. Moreover, Weber-Lewerenz (2021) emphasise the need to facilitate studies investigating the acceleration of digital transformation in construction. Similarly, Zulu and Khosrowshahi (2021) acknowledge the need for research to explore the success factors that would articulate the current digital adoption rates and the role of leaders in doing so. A review of literature, therefore, proves a lack of similar research, shedding light on a research gap concerning the factors that determine an effective digital transformation (Zulu et al., 2023). Despite the immense potential for digitalisation to offer key opportunities long due by the industry, the underlying indicators that can determine a transformation are yet understudied, presenting an opportunity for an exploration to address such a knowledge gap. Through a qualitative investigation, this paper seeks to pursue an understudied viewpoint to reveal whether patterns of data could mirror employees' consensus that particular variables can act as determinants of wider digital uptake among construction firms.

3. Research method

This paper has adopted a qualitative research method to capture participants' inputs when approaching the study's primary aim. The qualitative choice was driven by the nature of the topic which demands an in-depth understanding of the extent of interviewees' narratives, the nuances of their experiences, and the influence of their social interaction. Such a drive means that the rationale for selecting a qualitative approach is supported by the need for a subjective interpretation. Such an approach is interested in participants' perceptions framed from their thoughts and memories (Taylor et al., 2007). Hence, as Alsaigh and Coyne (2021) described, this paper adopted a qualitative research method that pursues and generates understanding from interpreting data.

As a research instrument, this paper adopted a survey approach through utilising an open-ended qualitative questionnaire to collect data. Open-ended questions grant participants more flexibility to articulate their inputs (Abutalibov and Guliyev, 2013). This qualitative tool encourages communication and conveniently captures misconceptions that help understand social phenomena (Agustianingsih and Mahmudi, 2019). Such a tool is highly relevant to this study, as it allowed employees to respond with free textual information to describe their organisation's position from digitalisation. Moreover, this study focused on involving early career professionals and middle management personnel as a research sample due to being described as the digital ambassadors in construction firms (Jacobsson and Linderoth, 2021), and due to achieving a less biased output compared to seeking data from higher positions to describe their own decisions (Zulu and Saad, 2023). Hence, investigating a viewpoint that challenges the bias of existing research aligns with the research community's responsibility and acts as an additional motive for this study. This choice led to collecting all of the data within the first three weeks of releasing the questionnaire.

Convenience sampling was utilised to collect data based on the convenient availability of participants in terms of time, location, access, and willingness to get involved (Whitehead and Lopez, 2016). Conditioned to being construction professionals, participants were encouraged to identify what determines an effective digital transformation in their organisations without any constraints on broader illustrations and discussions. Overall, participants from 38 construction organisations agreed to participate in this qualitative study, generously providing their perceptions by responding to a diverse set of questions. Individuals representing construction organisations ranged from local contractors to large international companies involved in vast construction and infrastructure activities and developments. All of the participants received the same questionnaire, and questions sought information on the organisational characteristics, level of digital uptake, digital readiness, general and specific perceptions, barriers, and leadership roles. These questions were designed with the intention to provoke as much information as possible to satisfy the objectives of this exploration. The number of participants may be perceived as small; however, data shaped a detailed perspective in line with this study's aim, deeming it sufficient to identify their experiences of a phenomenon (Starks and Trinidad, 2007). This is because qualitative methods are not influenced by sample size but rather by data saturation (O'Reilly and Parker, 2013). Overall, participants are classified as 21% entry-level employees, 61% construction professionals, 5% middle managers, and 13% first-level managers.

Due to the overwhelming amount of data, the analysis of the qualitative inputs includes condensation (Rabiee, 2004). Subsequently, data was analysed thematically and inductively. This means that recurring themes of importance have been identified based on data patterns (Boyd and Ashley, 2006), without referring to any set of pre-

191 determined constructs or themes (Hayes et al., 2010). To achieve this, the use of Nvivo
192 software facilitated the process by enabling the authors to visualise the data (Dalkin
193 et al., 2021). Hence, the analysis process can be described as iterative and based on
194 subjective interpretations in pursuit of the knowledge relevant to what determines an
195 effective digital transformation in the construction anecdote.

196 **4. Analysis**

197 The paper aims to capture participants' perspectives to understand what determines
198 an effective digital transformation among construction organisations. Data is analysed
199 using a thematic analysis acknowledged as practical for qualitative methodologies
200 (Braun et al., 2022). Analysing first-hand inputs is closer to an inductive reasoning
201 approach in the thematic analysis due to themes emerging naturally (Nowell et al.,
202 2017). This section captures the factors while following Braun's (2021) guidelines for
203 generating themes, underpinning relationships, and reporting. The following
204 subsections depict the determinants believed to influence digitalisation (see Figure 1).

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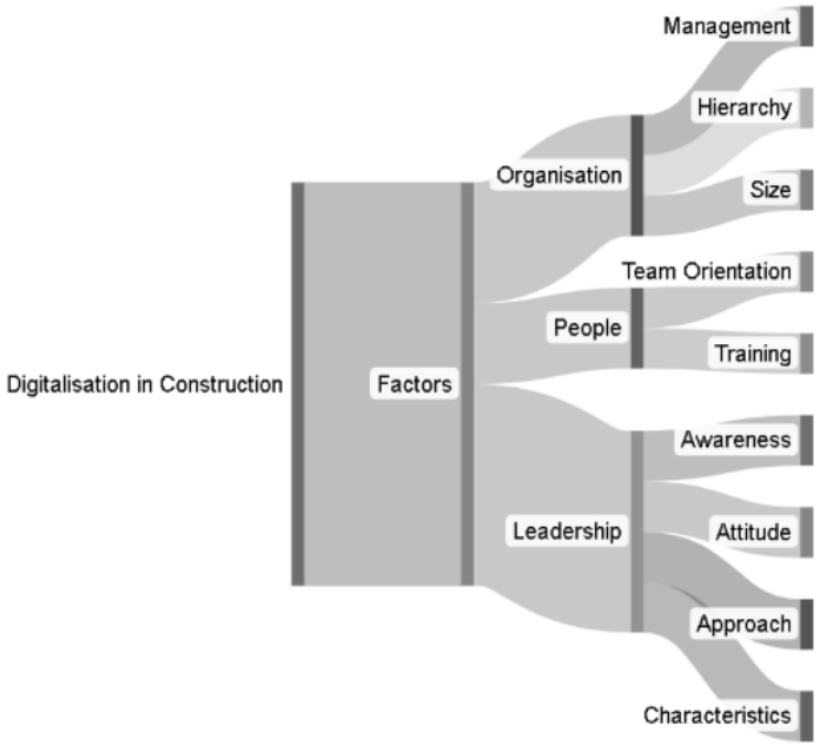

Figure 1: Factor clustering determining digital transformation in construction organisations

4.1. Organisational management

Participants reflect that the absence of a leader to bridge the gap between higher management and team members limits a digital transformation; "*too big a gap between the main people at the top and day-to-day team leaders*" Participant 3 (P3). Moreover, board members' reluctance to change may restrict leaders' ability to embrace digitalisation; "*managers are keen but encounter resistance from the board*" (P22). Organisations keen to implement digitalisation from the higher levels are recognising and capturing the benefits and values of transforming towards a more digital stance; "*my organisation is very management driven (top-down)*" (P23). Therefore, it is critical to sustain a relationship between the higher management, board members, and employees at the management level yet to be directly involved in daily tasks to drive leadership effectively.

Participants report characteristics lurking at the top managerial levels and undermining digital leadership; "*old school management that sits at the top of the organisation*" (P14). Moreover, participants reflect more focus on the roles, such as directors; "*directors being resistant to change*" (P22), and emphasise education as a solution; "*we need to be better educated from the top*" (P14). In contrast, organisations comprise roles occupied by individuals keen to drive digitalisation to facilitate the leadership position within the organisation; "*The VP I work under is an advocate and driver for digital transformation, but he is a minority*" (P36). Middle management incorporates roles of moderate influence; "*there needs to be a drive from the top*" (P15). Such aspect reveals that the more time a position is held, the less innovative a manager would be due to the growing tendency to normalise needs and get satisfied with a specific threshold of organisational performance; "*leadership has been in place for a long while*" (P36). Hence, effective organisational management is determined by a culture that supports modern approaches, employment of highly experienced and educated directors, not solely relying on middle managers to drive change, and finally, the period of employment in leadership positions.

4.2. Organisation's hierarchy

Participants have provided their views on the hierarchy and structure of their organisations, reflecting that multiple levels of management in an organisation are a barrier to broader digitalisation; "*many levels of management*" (P11). Moreover, it is critical to understand the influence of a more extensive hierarchy organisation than a less hierarchal one—the more hierarchy within an organisation, the more complexity is associated with reaching an innovative decision; "*Due to the decentralisation of the company's structure and organisation, and although instructions come from the parent company regarding modelling and unifying standards in relation to modernity systems,*

it is difficult for managers in company's branches here at our region to adhere with it" (P32), "*the processes naturally cascade down, and so the leadership-driven processes are very effective*" (P14). Whereas the less the hierarchical structure of an organisation, the faster an informed innovation-decision is made; "*If someone has a new initiative, it is out to everyone where we have a group discussion on the matter*" (P28). Moreover, the diversification of departments is described as evidence of embracing innovation and an incentive to sustain an effective digital advancement; "*understaffed in that area*" (P22). Hence, multiple levels of management create a gap between the levels that would ultimately lead to complex hierarchies, constraining an effective digital transformation.

4.3. Organisation's size

The organisation's size is critical when determining an effective digital transformation among construction organisations; "*the company is relatively small and was built up from a small organisation to what it is by two joiners. This has made them reasonably traditional.*" (P35). This is being linked to the limited organisational capabilities in terms of time and money; "*as a small organisation the amount of time and money available to actually invest in this area is minimal*" (P12). Therefore, the organisation's size may determine achieving an effective digital transformation.

4.4. Team orientation

Being team-oriented is emerging as a factor that reflects a positive determinant towards an effective digital transformation; "*Listen to their employees about how changes and upgrades in digital technology can be beneficial*" (P3). Building a team-oriented stance within an organisation achieves an innovation-supporting environment that, in return, boosts an effective digital transformation; "*members of staff given time*

to develop and learn more" (P5). This implies that despite the top management views and values, leadership at a team level can still effectively drive a positive culture towards innovation and digital transformation; "*most changes are staff driven*" (P25), "*we work together as a team to produce designs*" (P1). In contrast, the same population within an organisation can hinder a more comprehensive digital transformation; "*Insufficient feedback from staff as to the effectiveness of initiatives*" (P23). Forming an oriented team would require leaders' involvement to achieve transformation; "*has strong leadership backing and to champion their work at the highest levels of the organisation, helping them spread the word, engage teams worldwide and encourage others to get on board or risk being left behind*" (P8). Overall, despite being beneficial at an employee level, achieving an oriented team is encouraged and governed by leaders; "*We have a dedicated team for this*" (P9). Therefore, a team-oriented mindset is critical to a fundamental and practical digital transformation in construction organisations.

4.5. Knowledge and training

Another determinant to achieving an innovation-friendly organisation towards an effective digital transformation is the ability of the firm to promote knowledge and training; "*I personally am able to implement the information received at the university at work imminently*" (P24), "*increase exposure to training and development in the digital age*" (P3), "*knowledge of digital technology*" (P18), "*Need more training and more proactive to go with the trend*" (P26). Leaders are being called to play a significant role in facilitating a knowledgeable organisation; "*I find it is enforced with lack of understanding or direction leading to impatience and scepticism*" (P25). An aspect believed to be linked to the lack of training among leaders themselves; "*They adopt what is only necessary*" (P37). Therefore, to achieve an organisation that

welcomes innovation and digitalisation, it is necessary to attain proper knowledge through training at both leader and employee levels.

4.6. Leadership Awareness

Participants provide their perspectives on their organisation's leaders' awareness of digitalisation; "*The leader now understands the importance of change for the business's survival*" (P26), "*The Senior Management team acknowledge the fact that they need to keep up with the digital world and use it to create a competitive advantage*" (P3). Similarly, the influence of awareness on digital adoption is also reflected in organisations with low digital uptake; "*They don't understand the importance of the digital transformation*" (P6). Participant P35, however, reflects a primitive situation where even BIM was not recognised within the organisation; "*I would say they are not very prepared. For instance, the topic of Building Information Modelling came up in a tender and they did not know what it was*" (P35). Therefore, the above insights could reflect that leader's awareness is the critical step towards an effective transformation.

4.7. Leadership Attitude

Participants' perspectives on their leaders have provided a variety of inputs on their leaders' attitudes, informing the study of another determinant towards digital transformation. Organisations employing leaders with a positive attitude toward digitalisation have greater digital uptake; "*Open-minded to try new methods and strategies*" (P12), "*the managers and team leaders are very keen to adapt to digital processes*" (P14). In contrast, an unsatisfactory leadership attitude is being shared by participants from low digitally driven organisations; "*Management is more focused on current achievement and has less attraction for the long-term investment*" (P7), and

awareness; "*they are uninterested and do not see the benefit*" (P35). The discussions made infer that organisations with opposing leaders' attitudes reflect a negative digital uptake, identifying the same as a digital transformation determinant within construction organisations.

4.8. Leadership Approach

Participants are asked to provide their perspectives on the leadership approaches within their organisations. Tentatively, answers reflect the lack of a well-organised strategy being fostered by leaders, such as "*Scarce*" (P29), "*negative and passive approach*" (P7), "*non-existent*" (P18), and "*very resistant*" (P20). Participants, however, agree on the role leaders should play in driving an effective digital transformation; "*It is part of every leader's role to guide business through its digital transformation*" (P8). To identify the strategies and trends practised by leaders, participants have shared their perspectives on the successful approaches; "*Leadership approach open mind persons, improving organisation system and update the system periodically*" (P31). Other participants share that such strategies are yet unclear, reflecting the ambiguous approach practised by the organisation; "*The approach is still not clear in our company regarding digital transformation*" (P32), "*Some leaders have been driving this as they understand the benefits*" (P33). Hence, a clear digital strategy is critical in a leadership approach that seeks digital transformation.

An unclear leadership strategy in seeking digitalisation may lead to an ineffective attempt; "*they did outsource IT support to an external company which hasn't gone too well*" (P27), "*systems are old and clunky*" (P34). Moreover, a strategy that extensively forces employees to adopt digital technologies may not be a practical

leadership approach. A penalty approach is said to be effective when associated with an incentive approach; "*individuals are penalised for not completing tasks even if there is an issue with the technology which is out of their control*" (P19). Participants, however, provided their perspectives on the leadership approach as a determinant for an effective digital transformation, providing suggestions such as the need for "*coordination between the top brass*" (P36), *"engagement with transformation initiatives*" (P4), *"asking for feedback*" (P11), and "*researched before implementation*" (p14). Hence, an incentive-driven strategy, seeking regular feedback, welcoming individual initiatives, and being up to date with digital trends are all determinants of a leadership approach that is believed to drive an effective digital transformation.

4.9. Leader characteristics

Age is emerging as a determinant within leaders' characteristics, highlighting that the demographic nature of an organisation, particularly leaders, can influence digital adoption; "*the company has a young demographic, so everyone is computer literate and recognises the opportunities digital applications offer to the organisation*" (P13). As a result, a positive influence emerges between age and innovation, which is identified as a particular driver of innovation in family firms; "*I work for a family business, and therefore it would only be the younger generations that would be willing to learn the new programmes*" (P28). This as well raises arguments on the influence of age driving positive output. Overall, participants reflect on the impact of age, confirming the above discussions and sustaining a critical factor within leaders' characteristics influencing broader digital change; "*being of the older generation and does not understand how the technology work*" (P17), "*the age of people in leadership positions"* (P27), "*we are fortunate to have a lot of younger people*" (P36). Participant 28 also notes that due to this generation being in their positions, the sequence of

priorities differs, and hence, digitalisation is not on the top of the list; "*it's not the most important factor within our company*" (P28). Therefore, it can be deduced that age has an inversely proportional influence on an organisation's digital transformation, where the higher the age of leaders, the slower an effective digital transformation is achieved.

Participants, additionally, provide several perspectives on their leaders' innovativeness. Few describe innovativeness as using unfamiliar workplace tools to enhance performance; "*using iPads at one site to aid delivery of complete digital delivery*" (P10). Others describe digital innovativeness as adopting software to aid their key processes; "*The company adopted a project management software 18 months ago*" (P14). Nevertheless, the availability of software is not solely seen as an indicator of innovativeness, but rather the existence of a willingness to transform these tools into value; "*we have access to all the software we need*" (P27), "*Well, they buy what I will ask them to buy*" (P37). Participant 30 shares the view of a public client for which willingness exists in the organisation; "*Wiling to embrace change*" (P30). In this context, willingness has led to embracing digital technologies even though it is bounded by trusting reputable solutions. This reflects that some organisations' pace of digital adoption is influenced by the explanations given by trusted digital firms; "*Working for a Council they are getting up to speed with Microsoft advancements*" (P30). Another aspect captured from analysing the participants' inputs is the sense of urgency; "*We adopt as we go. No rush*" (P37). Leadership innovativeness could hereby lurk as a critical determinant of an effective digital transformation in construction firms.

5. Discussion

Based on the results, nine factors cluster 35 digital transformation determinants in construction organisations. The logic flows to capture the relation between

organisational constructs related to organisations, people, and leadership on digital uptake. This section serves the study by discussing the results of this paper against past research efforts.

Findings underline the influence of the characteristics of higher management on the influential leadership role within an organisation through the use of the term 'old school' to reflect a mindset inhibiting change; such a character carries a conventional stance and may not be well equipped to embrace innovation or change (Broshi-Chen and Mansfeld, 2021). Results are consistent with previous literature revealing that directors can facilitate change (Network, 2015). More research is needed to highlight the influence of roles on digital adoption. Nevertheless, findings suggest that education is critical among higher management roles, an aspect that can facilitate more informed decisions and urge employees towards the innovation's direction (Psychogios et al., 2009).

The results of this paper, however, contradict leadership literature acknowledging the role of middle managers and their critical contribution in driving change and organisational performance (Mantere, 2008), and suggest that middle managers may only partially acquire an organisational changing capability in construction firms. In contrast to the common perception, findings suggest that the longer the time spent in higher management roles, the less the tendency to embrace change. Moreover, longer-tenured employees who have gained considerable experience and have standardised processes perceived as effective at a specific interval are more resistant to change (Brockner et al., 2006).

Discoveries in this study infer that less hierarchical organisations are more innovative than extensively hierarchical ones (Suh et al., 2018). Although little

research exists on the influence of an organisation's hierarchy on its innovation adoption, Tian et al. (2018) describe that it may aid innovation efforts. The findings of this paper suggest that the more complex an organisational hierarchy, the higher the constraints are to achieve an effective digital transformation. This is consistent with Phillips and Ritala (2019, p.10), who state that "hierarchy can create different issues at different levels and that these may also interact". Overall, fewer management levels mean more connectedness and fewer gaps, driving a less complex and diverse hierarchal structure that allows change to occur. Such a relationship has been highlighted by previous research emphasising the correlation between organisational structure and organisational performance (Gbadegeshin, 2013).

Participants have also highlighted the relationship between the organisation's size and digital transformation, arguing that the larger the firm is, the faster the digital transformation. This is consistent with Zulu et al. (2022), who report the influence of the organisation's size on its digital uptake. This can be explained by the limited access to the highly needed time and money only sometimes available in small-sized organisations (Xue et al., 2022). These insights align with Roger’s theory, the diffusion of innovation, where he describes early innovators as having larger units, i.e. more prominent companies, than late adopters (Rogers, 2003). Therefore, the organisation's size has been included as a determinant influencing wider digitalisation.

Similarly, team orientation is linked to successful outcomes in a firm's performance compared to those not fostering such collaboration (Kilcullen et al., 2022). Participants have highlighted the influence of employees on their leaders, where leaders' openness to sustain a team-oriented mindset would be by acquiring a more excellent abstraction capability (Midgley and Dowling, 1978). Leaders’ practices and behaviour influence the team's goals and priorities (Alexander and Van

Knippenberg, 2014). Achieving an oriented team, therefore, is driven by leaders instead of by employees themselves (Aryani and Widodo, 2020).

Employee knowledge is critical to effective change (Jones et al., 2005). Findings are consistent with Türkeş et al. (2019), who infer the vital need to improve firms' training and knowledge to enhance digital adoption. Organisations promoting training and knowledge excel in digital competence (Guinan et al., 2019). However, if leaders within an organisation are not well-trained and knowledgeable, the outcome will not favour digital uptake (Yang et al., 2014). This could be justified by the complex perspective of digitalisation and the selection process, deterring leaders from aligning their organisation's needs with effective digital technology (Pflaum and Gölzer, 2018; Zaheer et al., 2021).

Participants reflecting a positive awareness among their leaders tend to be from organisations that gather information on digital environments (Peillon and Dubruc, 2019). Leadership awareness is a critical determinant of change (Auvinen et al., 2019), driven by the leadership style that facilitates an effective transformation (Naqshbandi and Jasimuddin, 2018). Such a mindset is driven by cost (Müller et al., 2018) and awareness (Peillon and Dubruc, 2019). In contrast, an unclear strategy to implement and adopt digital transformation limits the exploitation of digital advantages (Hanelt et al., 2021). A clear strategy aids the organisation in seizing critical opportunities and maximising its digital experience (Singh et al., 2020). Findings suggest that a penalty approach is practical only when associated with a bonus approach (Aben et al., 2021). Therefore, it is how leaders orchestrate and frame their approaches to align with change, not vice versa, a philosophy described as critical when shaping an effective digital transformation strategy (Kim and Kim, 2022).

Findings suggest the existence of multiple characteristics that can differentiate leaders from firms with higher digital uptake compared to those lagging. Literature has previously identified the relationship between age and innovation (Santoro et al., 2021). Age influences leaders themselves, as older employees tend to be less driven towards innovation (Li et al., 2021). Moreover, leaders from family organisations tend to excel in fostering change, which aligns with Block et al. (2022) argument that family firms are "*doing more for less*" p.13. Additionally, Haider et al. (2021) infer that the innovativeness of leaders can be measured through their ability to accept and drive new ideas and concepts, hence, generally being open to innovation. This can be seen as trivial, as openness to innovation is reasonably a characteristic of successful digital leaders (S. M. Ferdous Azam, Normy Rafida, Mohd. Mousa Mustafa Odeh, 2021); nevertheless, it stands as another determinant in this paper. Finally, the availability of software does not necessarily mean the existence of sufficient reasoning for the change. There is a critical divergence between organisations offering the means of innovation and those driving innovation (Birasnav et al., 2022). Tentatively, late digital-adopting organisations need a sense of willingness and urgency to digitally transform (Fredberg and Pregmark, 2022). Such a determinant is described to be driven and not simply achieved by the availability of digital technologies but by the fundamental willingness to change.

Therefore, this study responds to the recent calls made by Zulu and Khosrowshahi (2021), Prebanić and Vukomanović (2021), Baptista et al. (2020) and Weber-Lewerenz (2021) on the necessity for research to study digitalisation across the construction sector, aligning with leadership theories (Müller-abdelrazeq, 2016), diffusion of innovation (Rogers, 2003), and organisational culture (Martínez-Caro et al., 2020). We can hereby state that an effective digital transformation is linked to

490 organisational determinants, undermining wider uptake; the captured determinants
491 are detailed in **Table *1***.

492 **Table 1**: Determinants of an effective digital transformation among construction firms

#	Factor	Determinant
	What determines an effective digital transformation among construction firms?	
1	**Organisational management**	1. Higher management change capacity
		2. Board members change capacity
		3. Directors change capacity
		4. Support to middle managers
		5. Period of employment
2	**Organisational hierarchy**	6. Management levels
		7. Connectivity of management levels
		8. Complexity of a hierarchy
		9. Diverse departments
3	**Organisational size**	10. Innovativeness of larger firms
		11. Financial capability of smaller firms
4	**Team orientation**	12. Abstraction capability
		13. Time for employees to upskill
		14. Incentives to employees
		15. Feedback from peers
		16. Leader-team behaviour
5	**Knowledge and training**	17. Culture that embraces learning
		18. Trained and educated digital leaders
		19. Effective digitalisation selection
6	**Leadership awareness**	20. Awareness of the benefits and advantages
		21. Awareness of competitive advantages
		22. Continues relative education
7	**Leadership attitude**	23. Positive attitude towards digitalisation
		24. Attitude driven by cost
		25. Attitude driven by awareness
8	**Leadership approach**	26. Clear digital strategy
		27. An incentive driven strategy
		28. Utilisation of employee feedback
		29. Research-based approach
		30. Engagement with individual initiatives
		31. Up to date with digital trends
9	**Leader's characteristics**	32. Leader's age
		33. Innovativeness
		34. Willingness to change
		35. Sense of urgency

493 ## 6. Conclusion

494 Digitalisation is forcing changes at multiple levels and requires a learning curve that
495 may challenge the stakeholders involved. This paper pursues knowledge using a

qualitative investigation to understand what determines an effective digital transformation among construction organisations. The key finding of this study is the need for construction organisations to alter their operations and suit a digital stance that focuses on the captured determinants as critical pressure points. This paper infers a basis that is considered empirical evidence of the limited analogous of existing literature, offering research and practice contemporary discussions to investigate further and validate digital adoption.

Overall, this study captures 35 determinants for an effective digital transformation in construction organisations. Findings suggest that digital education in higher management roles like directors drives more digital uptake. Moreover, middle managers need support from higher management to drive effective transformation. Tentatively, longer-tenured higher management positions influence less digital adoption. In contrast, organisations with innovation-driven higher management tend to facilitate the influential role of digital leaders. Also, organisations with younger demography have a higher uptake than those with older generations in leadership positions. Similarly, an organisation's size influences an effective digital transformation. Concerning knowledge and training, a practical approach would cascade from the leadership to the employee level, not vice versa. Finally, the availability of digital technologies is not proof of an effective digital transformation without the willingness and a sense of urgency towards implementation.

The implications of this study are twofold. Firstly, the approach aimed at construction professionals rather than the more popular approach of noting the views of construction leaders, an approach that led to minimising bias. Secondly, the paper explores the key factors and their determinants based on the in-depth analysis of vast qualitative data, and in turn, paving the way for other methods of assessment to

encourage future research to investigate facilitating digital transformation in the construction industry. Intuitively, the results of this study may seem to best fit the local context of the UK construction industry; however, the results are believed to be highly generalisable and applicable to the global construction setting. The orderly understanding of employees' viewpoints and their perception on the study's examined phenomenon is important for both the local and global construction professionals and managers seeking a strategical approach to deploy broader digitalisation throughout the different construction activities. The identified determinants therefore lay the foundation for a new argumentative approach that largely differs from what is presently offered by literature, as future research is encouraged to equally consider the social appeals in their quests towards greater use and application of digital technologies in the construction sector.

Despite this study realising its objectives, few limitations exist to encourage using the results with caution. The use of the exploratory method of an open-ended questionnaire is not unreasonable, but it is also not a validation of the extracted and clustered variables. Moreover, focus groups and face-to-face interviews can also be seen as potential methods for the continuation of this paper's objectives, these were however not possible herewith. Future research would focus on validating the determinants captured by this qualitative investigation through other methodologies towards underpinning a practical digital transformation guideline, i.e. quantitative validation.

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